A SYSTEMATIC REVIEW OF THE KNOWLEDGE, ATTITUDES AND BEHAVIOUR OF THE DENTAL TEAM AND THEIR ADHERENCE TO INFECTION CONTROL GUIDELINES

by

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PREFACE

The work described in this thesis was carried out at the University of Glasgow Dental Hospital and School, from October 1998 to September 1999, under the supervision of Professors Trevor Burke and Jeremy Bagg.

This research represents original work carried out by the author and has not been submitted in any other form to any other university.

DECLARATION

This thesis is the original work of the author

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SUMMARY

The increased profile of infections arising from blood-borne viruses such as human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV) since the 1980s has resulted in an examination of dental surgery infection control procedures. Infection control procedures in dentistry principally protect the patient from micro-organisms present on the dentist's hands and on instruments or equipment used on previous patients. A secondary function of some infection control procedures is the protection of the operator from micro-organisms which may be present in the patient's mouth. In these respects, many guidelines have been issued to dental health care workers (DHCWs) concerning, for example, the wearing of gloves, masks, and the autoclaving of handpieces. Such guidelines are typically published by dental representative associations or government bodies such as the American Dental Association, the British Dental Association and the Centers for Disease Control (Council for Dental Materials and Devices 1978; Centers for Disease Control 1986; BDA Dental Health and Science Committee Workshop 1986). These recommendations have been reviewed regularly, with additional recommendations being made such as the changing of gloves and the autoclaving of handpieces between each patient (American Dental Association Council on Dental Materials 1992; British Dental Association 1996). However, compliance with such guidelines by GDPs has never been universal (Burke, Wilson and Wastell 1991; Verussio, Neidle and Kash 1989), for reasons such as cost, problems adapting to glove wearing and the fact that few reports have been published demonstrating transmission of infection in the dental surgery. The purpose of the present review was therefore to investigate the

dental team's knowledge, attitudes and behaviour with regard to infection control and relevant guidelines.

The present review outlined three objectives: to determine the knowledge and attitudes of GDPs towards infection control procedures; to determine the DHCWs practising behaviour in respect of infection control; to determine whether a relationship exists between knowledge, attitudes and behaviour (e.g. adherence to guidelines). Several study designs were considered for inclusion: randomised controlled trials (RCTs), controlled before and after studies (CBAs), interrupted time series studies (ITSs), observational studies, surveys and reports of infection control procedure uptake. Potential studies focused on participant groups which included dentists, dental surgery assistants (DSAs), dental hygienists, dental therapists, dental students, dental laboratory workers i.e. the broad group known as Dental Health Care Workers (DHCWs).

The review was based on the criteria, guidelines and standards produced by the NHS Centre for Reviews and Dissemination at the University of York and The Cochrane Collaboration, in particular the Cochrane Effective Practice and Organisation of Care Review Group (EPOC). Studies which described a standard of practice which, in the reviewers' judgement, implicitly met the definition of an infection control guideline were included. Studies were included which evaluated the effectiveness of guidelines as well as studies evaluating different dissemination and implementation strategies. Studies were also considered if outcomes such as glove use, mask use, use of protective eyewear and the changing of these items between patients; the wearing of protective clothing; the

sterilisation of instruments and handpieces between patients; the disinfection of surfaces; hepatitis B vaccination of clinical staff; use of disposable items and waste disposal; training of all staff in the principles of infection control; knowledge of the dental team regarding blood borne infections; willingness, primarily of dentists, to treat HIV positive patients; existence of an infection control policy, an accident book for the recording of occupational injuries and post-exposure protocol for each practice were measured. Both observed and self-report measures of these outcomes were considered.

A range of methods was used to identify reports of relevant primary research with no language limitations being implemented. Electronic databases were searched for both published and unpublished literature, references of uncovered articles were scanned, key journals were handsearched, experts were contacted and reference was made to conference proceedings and abstracts from professional meetings. Database searches produced 2,420 articles of which 1,985 were excluded on screening. After obtaining hard copies of 435 full text studies, 71 were found to meet the necessary criteria.

The quality of each study was assessed according to the pre-determined criteria. This task was undertaken by two reviewers independently, as was the extraction of data from included studies and the data analysis, in order to increase the reliability of the review. However, the poor quality of the literature available in the field of infection control was highlighted by the fact that only one RCT was uncovered, but it too was flawed. The dominance of questionnaire-based surveys introduced considerable bias in terms of study design, as well as the subjective method of measurement employed. For this reason,

caution must be observed when interpreting the findings of such studies. Due to the heterogeneous nature of the literature, qualitative synthesis of the data was carried out as quantitative analysis would prove worthless.

If one defines adequate compliance as not less than 100%, the studies included in this review suggest that the overall rate of adherence to infection control guidelines in the dental profession is less than adequate and therefore needs to be improved. Several measures, such as hepatitis B vaccine acceptance and the sterilisation of hand instruments, are indicative of an increase in compliance with guidelines, but these successes are far outweighed by shortcomings. In particular, post-exposure follow-up, vaccination follow-up and impression disinfection are measures which tend to be overlooked by the dental team and require attention. Gaps are also evident in the dental team's knowledge of infectious diseases and cross-infection control. By improving their knowledge by means of interventions, the attitudes and behaviour of the team may follow suit.

Current guidelines are explicit and widely available to the dental team, but the policing of their implementation could be improved. By setting up independent bodies to deal with practice inspections, the rate of guideline compliance could perhaps be increased. To help in this task, researching of the key indicators of guideline adherence would enable a checklist to be developed and to be used by independent practice inspectors to pinpoint non-compliant practices. The level of occupational health support could likewise be improved in practices in relation to hepatitis B vaccination follow-up and follow-up to occupationally acquired injuries, both of which have been highlighted as key problem

areas. Furthermore, the role of the dental surgery assistant is central to infection control, however, the rate of adherence within this particular group is inadequate and requires attention. An equalising of standard training and certification, on a global scale, may rectify this situation.

A systematic review of the literature has indicated that new methodological techniques need to be introduced for the assessment of the dental team's compliance with infection control guidelines. Inclusion of a greater observational element within study design may help to reduce the socially desired responses resulting from the questionnaire-based and interview survey data currently available and offer more reliable answers to the questions being posed. This points to an urgent need for a properly structured contemporary examination of dental practice infection control world-wide, using optimum methodology.

CHAPTER I

GENERAL INTRODUCTION

PART I

WHY THE NEED FOR INFECTION CONTROL?

At the root of infection control is an understanding of microbiology, the study of microscopic life forms known as micro-organisms, which include bacteria, viruses, fungi and protozoa. Each group of micro-organisms differs from the next in terms of structure and function, but members of all of them can survive within the human body. The discipline of microbiology is largely focused on gaining a fuller understanding of the physical and chemical properties of individual micro-organisms, where they exist, how they thrive and cause disease.

It was perhaps for this reason that the existence of micro-organisms was only suggested in the 16th Century. It was in 1546 that the Italian physician, Girolanio Fracastonio, was accredited with the realisation that tiny living forms are responsible for people 'succumbing' to disease. With the help of a basic microscope, such life forms were reportedly seen for the first time by Antoni van Leeuwenhoek in 1667. He amusingly referred to these as 'animalcules'. The association between these animalcules and the development of disease was fully realised during the mid to late 1800s, marking the 'Golden Age of Microbiology'. Many scientists made their names within this field – Louis Pasteur of France, Robert Koch of Germany, Ignaz Semmelweis of Austria, Oliver Wendell Holmes of USA, Lord Joseph Lister of Britain and perhaps the most important of all for dental research, the American W. D. Miller who became know as the Father of Oral Microbiology.

In the intervening years, the role of bacterial micro-organisms in such diseases as tuberculosis, tetanus, epidemic meningitis, pneumonia, food poisoning and dental caries

became clear. In 1898, scientists made the discovery of infectious agents which were smaller than bacteria. These were named 'viruses', the Latin origin of poisons. A virus differs in structure. It is composed of nucleic acids (DNA and RNA), enzymes, structural proteins and, in some cases, lipids. Following the advent of the electron microscope in 1940, well known diseases such as chickenpox, mumps, the common cold, hepatitis A and influenza were all shown to have a viral aetiology. In the years that have followed, numerous diseases and their causative agents have been isolated and new diseases continue to emerge. One particular agent which has received a great deal of media coverage in recent years underlies Creutzfeld-Jakob Disease, the human form of scrapie-like diseases found in animals (Advisory Committee on Dangerous Pathogens, Spongiform Encephallopathy Advisory Committee, 1998). Attention has been focused on this particular agent not only because of its transmission to humans from animals but also the fact that it fits into the group of unconventional agents known as prions. These proteinaceous infectious particles differ from viruses as they lack any DNA or RNA.

Despite the fact that the majority of microbiological research involves the negative aspects of these tiny life forms, micro-organisms can have beneficial effects. For example, the bacteria present in soil can convert dead plants, animals and insects into reusable nutrients. The dairy industry relies heavily on bacteria in the production of yoghurt, sour cream and many cheeses. Modern sewage treatment plants utilise bacteria in the process of breaking down the organic material. Bacteria and yeast can also have positive uses within the health profession for the synthesis of a variety of hormones, including insulin, and the hepatitis B vaccine. Indeed, the principal function of micro-

organisms is not to cause harm but simply to grow and to multiply. Harmful effects of their growth become evident when they contaminate other areas where they should not be present. The name 'infectious diseases' is given to disorders in which specific micro-organism types enter the body, multiply and damage the tissues. Such micro-organisms are known as pathogens and can be one of two types. Endogenous pathogens are naturally present in or on the body and only cause harm when given the opportunity to enter deep tissues or when they accumulate to harmful levels. Only when these scenarios arise do they exert their 'disease producing potential' (Miller & Palenik, 1998). Oral flora naturally present in the mouth can produce such an effect, resulting in dental caries, periodontitis or pulpitis. Exogenous pathogens, on the other hand, are not normally present in or on the body and when they come into contact with the human body they contaminate it, sometimes without even entering the body itself. Diseases such as hepatitis B, AIDS, measles, chickenpox, the common cold and influenza cause infection as can toxigenic organisms which multiply and produce toxins, for example, *Staphylococcus aureus* and *Clostridium botulinum*.

Having entered the body, the micro-organisms can maximise their development in several ways. By attaching to host cells or other surfaces, the multiplication process can be facilitated and infection enhanced. One of the first lines of defence within the body is in the form of phagocytes. However, bacteria that are encapsulated can bypass this defence mechanism, thereby interfering with the body's defences. Another option is to do direct damage to the body. Bacteria and fungi are able to secrete extracellular enzymes as they grow which can affect macromolecules which, if part of the host cell surface or tissue

components, can lead to direct damage to the tissue. Waste products of bacteria can also have detrimental effects on the surrounding cells. Viruses tend to interfere with the functioning of the invaded host cell. All types of micro-organism release substances which trigger a protective inflammatory response, but if continually triggered this response can do more harm than good. This is the case when plaque is continually present in periodontal pockets which is at the root of periodontal disease.

As is evident, micro-organisms do not exert their negative effects without a fight from the host cells and the body's immune system. For this reason, immunology plays a large role in the field of microbiology. A detailed understanding of the body's defence mechanisms against micro-organisms is required. The French scientist Louis Pasteur came to be known as the Father of Immunology, as he was aware that some form of physiological response must be taking place within the body as often people would 'catch' a disease but never have it a second time. This process we know as immunisation. Acquired immunity occurs when the body develops a defence mechanism against the attack of a specific micro-organism. When the micro-organism enters the body, lymphocytes are there to defend their territory. Artificial immunity can be produced by inoculating an individual with a dead micro-organism, a weakened micro-organism, the antigenic part of the micro-organism or an inactivated toxin of the micro-organism in question. Instead of causing disease, the vaccine will stimulate the natural immune response and if the individual encounters the 'real' organism, the defence mechanisms will be present to deal with it. This protective effect can be lifelong but certain responses have to be boosted at regular intervals.

The Golden Age of Microbiology brought with it not only an understanding of diseases and their causative agents but subsequent consideration of means of preventing such infections. Discoveries such as the importance of handwashing in the prevention of infection and the use of heat treatment in killing resistant bacterial spores form the basis of the infection control techniques in place today.

Within the dental surgery thousands of types of microorganisms are present in the mouths of patients (Bagg, 1996). Patients' saliva, respiratory secretions and blood are all potential sources of infection. Due to the close proximity of the dentist and the patient, pathogens can be transmitted by direct contact, injuries suffered from contaminated instruments or sharps, or droplet infection, in the form of aerosol or spatter. Contamination most often occurs percutaneously if a member of the dental team has a small cut or abrasion through which transmission can occur. Mucocutaneous transmission can also take place if contaminated fluids come into contact with the eyes, nose or mouth. Many infectious diseases are asymptomatic in their preliminary stages, making it difficult to ascertain the carriers of particular diseases. The principal of infection control therefore has to be applied to all patients to **prevent** transmission of infectious diseases.

Several diseases are at the forefront of legislation related to infection control within the dental profession. Diseases such as viral hepatitis, herpes virus infections, tuberculosis, the human immunodeficiency virus (HIV) and the more recently isolated CJD agent are familiar to both dental health care workers (DHCWs) and the patients they treat. The individual hepatitis viruses are specific in their manifestation and their route of

transmission. Hepatitis A, for example, does not pose any particular threat for dental health care workers. It is principally transmitted via the faecal-oral route or contaminated food or water. A vaccine is available and is normally advised for people travelling to countries where the sanitation is poor. Hepatitis B, on the other hand, is a major problem for dental team members (Cottone & Puttaiah, 1996). This infection manifests itself as inflammation of the liver, as the enveloped DNA virus invades human liver cells where it then multiplies. The infected individual may present with symptoms such as jaundice, a rash, itching, joint pain, fever, light coloured stools and dark urine. A feeling of malaise, loss of appetite, nausea or abdominal pain are less well recognised symptoms but are consistent with this particular infection. Any of these symptoms normally present themselves two and a half to six months following exposure. However, the carrier develops the risk of transmitting the disease when the cells containing the virus are released into the bloodstream and to other body fluids.

It is at this point that others are at risk of contamination. The hepatitis B virus itself is particularly infectious, for as many as 100 million virus particles can be present in one millilitre of infected blood (Bagg *et al.*, 1999). This high level of infectivity results in only a very small amount of contaminated blood being needed for transmission to occur. The virus consists of several components, including the surface antigen (HBsAg) and the core antigen (HBcAg). If and when infection occurs, 90% of people make a full recovery. Of the remaining 10%, some become chronic carriers, and are infectious to others, in addition to running a risk of cirrhosis or primary liver cancer. Others eliminate it completely from their bodies over the course of two and a half years.

As the markers of the disease are now known, blood products can be screened for contamination. In the dental surgery, precautions have to taken as there is no cure. A number of preventive measures are available. A hepatitis B vaccine was developed which stimulates the immune response following inoculation with genetically engineered HBsAg. The Occupational Safety and Health Administration (OSHA) have in fact recommended that all health care workers be vaccinated and that dentists make the vaccine available to staff without charge. The fact that the virus can be killed relatively easily by heat sterilisation offers the dental team another route whereby they can exert control over the disease.

Its high infectivity and ease of transmission make hepatitis B one of the most dangerous pathogens for the dental profession. Results of synthesis of surveys carried out between 1975 and 1982 of DHCWs HBV status estimated that 13% of dental surgery assistants, 17% of hygienists, 14% of laboratory staff and between 9 and 25% of dentists were HBV infected (Miller & Palenik, 1998). This reflects the high risk of infection for the dental team, since according to the Centre for Disease Control and Prevention (CDC), 1-1.25 million Americans carry the disease. However, there is also the need for infection control measures to protect the patients being treated.

The disease previously referred to as non A, non B hepatitis has now been given status and its harmful effects recognised as hepatitis C. This RNA virus comprises six variations (genotypes) and as many as forty subvariations (Porter & Lodi, 1996). As hepatitis C virus has been isolated from most body fluids, the opportunities for transmission are high.

As a consequence it is thought that as many as 30% of hepatitis related cases in the US are the result of hepatitis C infection. Chronic carriage can develop in 70 to 80% of those infected, which may result in cirrhosis or hepatocellular carcinoma. Transmission by parenteral routes offers a considerable window of opportunity for transmission. Blood contact, the sharing of needles, use of blood products, sexual contact and mother to baby offer routes for potential transmission. The majority of hepatitis C cases are found in intravenous drug users, 13% result from unprotected sexual contact, 3% from infected blood products and 1% as a result of occupational exposure. Developments have been made in this area of research in recent years. In 1991, a blood test became available to detect the presence of hepatitis C antibodies. The discovery of a vaccine may be many years away as those developed for viruses A and B offer no protection. Despite the fact that hepatitis C is less infectious than hepatitis B, the lack of vaccine and isolation of the virus from saliva (although in low concentrations) renders prevention in the dental setting of paramount importance.

Hepatitis D, E and G viruses have likewise been recognised as infectious agents in their own right (Bagg *et al.*, 1999). The delta agent is strongly linked with hepatitis B and appears to be a slightly different expression of the hepatitis B virus. Hepatitis D only causes infection in the presence of hepatitis B and their association is further strengthened by the fact that hepatitis B vaccine **should** prevent infection by the D virus. Hepatitis E shows similarities with hepatitis A as its routes of transmission are likewise via contaminated food or water. This type of virus is predominantly found in Middle Eastern countries. Since its discovery in 1995, a great deal of work is being undertaken to

determine the nature of the hepatitis G virus and its means of infection which is presently thought to be bloodborne.

Comparable with hepatitis in terms of its variations, the herpes group of viruses can manifest in several forms. Human herpesvirus type 1 is present in 90% of adults, but the typical symptoms of infections of the mouth, skin, eyes and genitals only present themselves in 10% of carriers. Herpes viruses generally cause recurrent diseases, the most notable being **herpes labialis** which underlies cold sores. Contact between aerosol, unwashed hands or direct contact with the lesion can result in transmission but perhaps more worrying for dentists, is the fact that the virus particles can be present in the carriers' saliva when no lesions are obvious. Type 2 is principally associated with genital infections which again are recurrent and can be transmitted by direct lesional contact but also when no lesions are present. Herpes Type 3 manifests itself as chickenpox or shingles while type 4 infection is associated with infectious mononucleosis and hairy leukoplakia of the tongue.

Human herpesvirus type 5 infection can produce different symptoms, depending on who is infected. Known as cytomegalovirus, type 5 virus can cause congenital disease, often resulting in death. Those affected may show signs of mental retardation, deafness, sometimes internal organ damage. Spread by saliva, blood, semen, vaginal secretions and breast milk, HHV-5 is normally asymptomatic in otherwise healthy adults but can have devastating effects on those who are immunosuppressed. Infection can facilitate pneumonia, gastro-enteritis and even hepatitis. HHV-6 can be isolated from saliva and is

linked to roseola (a high fever and skin rash in infants) (Bagg, 1994). Type 7 can likewise be isolated from saliva in 70 to 80% of adults and children but it is not associated with a specific disease. Type 8 virus forms the basis of Kaposi's sarcoma, a lesion found in the mouth and often associated with HIV infection. This can often be one of the early symptoms of HIV infection and thus appropriate knowledge on the part of the dentist can result in a prompt diagnosis and referral for treatment.

Of all the diseases which are prominent in the field of infection control, tuberculosis, a bacterial infection (*Mycobacterium tuberculosis*), poses the greatest health problem as it is thought to infect 10 million people each year, resulting in 3 million deaths worldwide (Miller & Palenik, 1998). *Mycobacterium tuberculosis* is an aerobic, non-motile, non-spore forming bacillus (Bagg, 1996) and can be detected by staining with carbol fuchsin or fluorochrome dyes. This bacterium causes an infection of the lungs. A diagnosis of tuberculosis is likely when one presents with symptoms such as malaise, a productive cough continuing for more than three weeks, blood stained sputum, headache, fever and weight loss. The groups at greatest risk of infection are the homeless, alcoholics, HIV carriers or those who have prolonged contact with carriers.

Although contact is not necessarily prolonged, the close proximity of the dental team and the patient presents a risk of cross infection (Roderick-Smith *et al.*, 1982). The actual risk depends on the concentration of tuberculosis particles (droplet nuclei) in the surrounding air, excreted by an infectious person with active pulmonary TB. These particles become airborne on sneezing, coughing or singing. Tuberculosis may not be considered in

relation to infection control policy as it is not a bloodborne disease (Pollack, 1995), but its prevalence causes sufficient concern to warrant action. Dental surgeries are enclosed environments and for this reason several infection control measures should be employed. Air filtration systems are a huge expense but by assuring effective ventilation of the surgery by the removal of contaminated air using directional airflow, the risk to staff and other patients can be reduced. Another method of reducing transmission is the passing of air over ultraviolet germicidal irradiation fixtures to which *Mycobacterium tuberculosis* is susceptible. The personal masks worn by the dental team members have shown no specific protection from transmission as the 'droplet nuclei' are very small (1 – 5μm) and therefore are likely to penetrate the material.

However, an anticipatory measure of immunisation is possible. A vaccine is available to prevent tuberculosis infection but its effectiveness is questioned by many people. The Mantoux test can be used to screen for infection. A small amount of the purified protein derivative of the bacterium is injected under the skin on the underside of the forearm. An assessment is made 48 – 72 hours later when signs of induration, or a hard nodule, provide evidence of a positive result. The BCG (Bacillus Calmette Guerin) vaccine involves a live attenuated bovine strain of the virus to produce a non-progressive form of infection, thereby offering protection against a more virulent strain. However, many health authorities, particularly in the US, harbour reservations regarding the effectiveness and safety of the vaccine and for those reasons do not encourage mandatory immunisation, as is the case for young teenagers in the UK.

For infection control, prevention is evidently the key. Yet, a new problem is now being faced, namely the multi-drug resistant strains of tuberculosis (MDRTB) which have appeared. Due to the high molecular weight of the lipids contained in the cell wall of *Mycobacterium tuberculosis* (Bagg, 1996), resistance to disinfectants and common laboratory stains can be exerted. This also seems to hold true for many types of antibiotic. An assessment carried out by the CDC revealed the extent of the problem. Of the most commonly used antibiotics such as isoniazid, rifampin and ethambutol, 15% of tuberculosis cases showed resistance to at least one of these drugs. Documented cases of MDRTB have predominantly involved immunosuppressed AIDS patients, hospitalised patients and institutionalised inmates whose immune systems may be compromised in some way by their routine medication. Present diagnostic tests are not efficient enough for drug resistance to be determined quickly and the drug regime altered accordingly to keep up with the development of the infection.

As the number of carriers in the community increases, the greater the number of infected individuals visiting dental practices. The CDC attempted to estimate the number of carriers in 1992 by inquiring of all dentists the number of active TB sufferers who had visited their practice within the last 12 months. Roderick-Smith *et al.* (1982) reported the case of an active TB infected dentist of whom 15 patients developed tuberculosis lesions following the extraction of teeth. This suggests the risk of infection in the dental surgery is real despite the fact that no surveys have been performed to address this very issue. What is certain is that a well-defined protocol for potentially infected patients visiting the dental surgery must ensure appropriate referral and management of care.

The media frenzy which has surrounded the human immunodeficiency virus during the late 1980s and throughout the 1990s has resulted in it being one of the most high profile diseases of this century. Infection by the virus, for which no vaccine or cure is available, results eventually in death and consequently has instilled terror in people all over the world. Although its infectivity is considerably less than other diseases, the association between HIV and mortality is a commonly held perception, and seemingly more so than for any other disease.

Human immunodeficiency virus itself was recognised in 1981. The final phase of the disease caused by this virus has been given the name Acquired Immune Deficiency Syndrome (AIDS). The virus, which targets the immune system, can take one of two forms. Type 1 is the most common form of the RNA or 'retrovirus' while Type 2 is a less aggressive form which tends to be seen in West Africa. HIV Type 1's destruction of the immune system focuses its initial efforts on infection of T_4 lymphocytes, or macrophages, the regulators of the immune system and a number of other cell types. After selectively attaching itself to the T_4 lymphocytes, the virus RNA is converted to viral DNA and incorporated into the DNA of the lymphocyte chromosomes. As the virus replicates, the immune system is weakened therefore increasing its susceptibility to other infections. The rate of production of the virus varies from one carrier to the next and it is for this reason that the duration of the disease can vary considerably from two and a half years to ten years or more. Duration of the disease may also be dependent on the genetic variation of the virus which can mutate once inside the lymphocytes.

An HIV diagnosis is given when antibodies to HIV are present in the blood. These antibodies usually develop 6 – 12 weeks after exposure. Following the initial infection, the infected individual can remain asymptomatic until their T_4 lymphocyte count becomes low. The first signs of the disease may manifest themselves in the mouth. Dentists can play a crucial role here, as can hygienists (Stevens, 1989), in the early diagnosis and referral of patients for medical treatment. Oral lesions which appear include fungal infections, candidiasis, histoplasmosis, bacterial infections such as rapid periodontitis, gingivitis, viral disease including hairy leukoplakia and HHV-1 as well as cancerous diseases, examples being Kaposi's sarcoma (a neoplasm believed to be caused by HHV-8) and non-Hodgkin's lymphoma.

Due to the bloodborne nature of the virus, HIV can be isolated from and is potentially transmitted by several types of body fluids. Publicity has focused largely on transmission by sexual contact, a behaviour which in essence places many people at risk. The disease was initially recognised within the American male homosexual population and it was not until several years later that scientists realised that it had spread to the heterosexual population. Unprotected sexual contact is today a risk which many continue to take but is the route of transmission most heavily targeted by public health programmes. Intravenous drug use is the second leading cause of HIV infection in the US. Many people who suffer bleeding disorders such as haemophiliacs or who receive blood transfusions have also been infected with the virus through no fault of their own and it is only now that implemented screening tests, developed in 1985, are available that blood products are considered safe. Isolation of the virus from blood, semen, vaginal secretions,

cerebrospinal fluid, synovial fluid, pericardial fluid, saliva, tears and urine explains the risk faced by health care workers on a daily basis. Amniotic fluid and breast milk can also be included in this list of disease transmitting fluids and indicates the possibility of maternal transmission. Indeed, approximately half of the babies born to infected mothers are HIV positive as a result of exposure in the womb, during delivery or from breast milk. The numerous means of transmission explains the disturbing figures published by the CDC which estimate that 31 million people are currently infected with the virus worldwide.

However, for DHCWs the risk is believed to be low from the evidence currently available. Consideration of a number of prospective studies focusing on the risk of HIV infection following occupational exposure by Crutcher *et al.* (1991), resulted in a consistent estimated risk of 0.5 to 1% (CDC, 1988; Gerberding *et al.*, 1987; Wormser *et al.*, 1988). Pusateri (1991) reviewed thirteen studies of health care workers who had suffered needlestick injuries and likewise found that the chance of seroconversion was fairly low, in fact one in three hundred. Pusateri (1991) suggested that the amount of blood percutaneously transmitted would decide the outcome. Seymour & Davies (1990) wrote a commentary in relation to the results of a 1987 British Dental Association (BDA) survey which indicated that no cases of HIV transmission from dentist to patient had occurred in the UK. No cases of transmission via saliva have been reported in the dental profession (Serb, 1994). This is perhaps explained by the low concentrations of the virus present in saliva (Groopman *et al.*, 1984; Ho *et al.*, 1985), in addition to the proteinaceous factor found naturally in saliva which seems to have an adverse reaction on

HIV. This factor is thought to have inhibiting properties which can reduce the infectivity of the virus (Fox *et al.*, 1989). Indeed, a study carried out by Flynn *et al.* (1987) studied 255 dentists, hygienists and dental surgery assistants who had been exposed to HIV contaminated saliva on 189 occasions. Not one subject developed antibodies to HIV. Although this sample was very small, the study serves its purpose of highlighting the low risk of infection. Nevertheless, contact on a daily basis with saliva and other body fluids, many of which are potential sources of infection, leaves dentists and their clinical staff susceptible to infection and only strict compliance with infection control measures will ensure this risk remains low.

Government health departments have exploited the publicity surrounding the virus to promote preventive behaviour. Control can be exerted over the disease in many respects by preventive behaviour and the risk of infection minimised. No vaccine is currently available as the virus' ability to genetically mutate once inside the lymphocytes means that no one vaccine will be sufficient in combating the virus. As a result, prevention is the way forward. Campaigns to promote safe sex have had some effect in educating people, but, as is inherent in human nature, there are many who still willingly take the risk. The emphasis on the drug-using community has not been to halt their addictive behaviour, as such a strategy would be unrealistic, but instead to stop them sharing needles.

Occupationally acquired injuries can occur sometimes even when due care and attention is taken. Health councils have published extensive documentation encouraging immediate reaction to such an injury. Prompt follow-up to occupational exposures can maximise the

potential response to drug therapy, if this is the course of action deemed necessary by a medical supervisor. Zidovudine (ZDV) or AZT is a nucleoside analogue which can inhibit reverse transcriptase. A combination of the benefits of AZT therapy and counselling of the risks provides the health care worker with the knowledge needed to make an informed decision and to start to come to terms with the event (UK Department of Health, June 1997).

Despite the fatalistic view of HIV infection, only one case of possible HIV infection in the dental surgery has been documented. The high profile case of Dr. David Acer, an HIV-infected dentist, struck fear in both the dental team and their patients as it came to light in the early 1990s. The facts of the case are that six patients of Dr. Acer's became infected with HIV following dental treatment. Some people have gone as far as to say that the dentist in question injected his own blood into the mouths of these patients. An inquiry was subsequently launched by the CDC and the Florida Health Department to review all the evidence relating to this case. Misconduct on the part of the dentist and the possibility of cross-infection from insufficiently sterilised instruments was investigated. Despite the fact that Dr. Acer's male lover, an HIV carrier, was treated in the surgery in question, the inquiry deemed it unlikely that transmission had occurred from the dental handpiece to other patients and instead direct contact of contaminated body fluids from the dentist to the patient was the most probable explanation. Barr (1996) and Brown (1996) hold this view with contempt as they both believe the investigation did not take full account of the evidence which suggested several of the patients infected had in fact other risk behaviours and could have been infected by another route. Although certain

pieces of evidence cast doubt over the reputation of many of the patients involved, DNA sequencing revealed a high correlation between the HIV viral strain of the dentist and his patients, thereby defending the conclusions of the CDC.

In the UK, a popular documentary series 'Panorama' aired a programme in July 1993 concerning the only case of dentist-patient HIV transmission to date. The programme itself focused on the possibility of HIV infection having resulted from the dental handpiece. This media coverage reinforced the need for handpiece sterilisation between patients amongst the dental profession. A backlash by dentists regarding the added costs was inevitable and calls for government subsidisation as yet have not been heard. Although 300,000 visits are made to the dentist in the UK each working day, this is the only documented case of potential cross infection of this transmissible disease. Watson (1993) voiced his concerns regarding the detrimental effect such publicity would be likely to have on the dental profession as a whole. Rather than making clear the low risk involved when receiving dental treatment, programmes such as this only succeed in dissuading people from seeking dental treatment, irrespective of the probable beneficial effects on infection control compliance, not to mention the programme's viewer ratings. Horowitz (1992) is in agreement with Watson as he believes that the media have disadvantaged dentistry over the years with intense coverage on the issue of amalgam then fluoride and now AIDS. The public's trust in dentistry as a profession has been knocked and dentists have a duty to educate their patients and to alter the way they value oral health in order to reduce patient anxiety and increase attendance.

Considerable efforts have been made to further assess the risk of HIV infection on a visit to the dental surgery. Surveys of infected personnel's patients offer a direct measure of possible transmissions. Scully & Porter (1993) reported the findings of a 1993 CDC report which detailed the results of HIV antibody tests carried out on the patients of known HIV infected health care workers. Not one of 11, 529 patients of 46 infected health care workers (HCWs) tested proved positive. 24 of these health professionals were dental health care workers. Of a further 7507 patients tested who had received treatment from 11 different HCWs, 92 were seropositive. Yet of those infected, a dental cause was not suggested by the evidence. Scully & Porter (1993) referred to the Veteran Affairs dentist from Florida who contracted HIV. In total, 900 former patients were tested for their HIV status with none appearing to be infected by the dentist. Those patients who were seropositive had other risk factors and five patients who did not, had a very different strain of the virus. The testing positive of a dental student in America led to the screening of 143 patients but none became infected through treatment. The Dr. Acer case remains the most high profile and evidence would suggest here that this is an extreme case – not one of routine dental treatment. From this evidence, the risk of being infected with HIV during dental treatment seems remote.

The most recently discovered infectious disease comes by the name of Creutzfeld-Jakob Disease (CJD). It made its appearance in 1996, when the association between the epidemic form of bovine spongiform encephalopathy (otherwise known as mad cow disease) and CJD was first recognised (Fishman *et al.*, 1998). The infection is thought to be caused by a prion protein, a protein which is host encoded but the function of which is

yet unknown. From a case study of an 83 year old, Fishman *et al.* (1998) found that spongiform changes of the vacuoles had taken place and spare filamentous structures had appeared in some glial cells. Unfortunately, the only way to confirm a diagnosis of CJD is by brain biopsy, although certain EEG (electroencephalogram) patterns may be indicative of the disease but, as yet, remain predictors.

An infected individual will develop key symptoms, for example, progressive dementia, ataxia, mental confusion and myoclonic jerks over a period of 15 months to two years before dying. The infectious agent at the root of these symptoms is particularly resistant to sterilising procedures and poses many problems for the dental team. The prion protein withstands higher temperatures in comparison with other agents which cause infectious diseases. Current recommendations suggest a more strict routine for the cleaning and sterilisation of instruments potentially infected by CJD, or ideally, use of disposable items (Fishman *et al.*, 1998).

As is evident, many infectious diseases pose a great risk for the health of the population and with the incidence of some of these infections continuing to grow, their transmission has to be curtailed. In health settings, such as the dental surgery, the nature of the work leaves people involved open to the possibility of infection and therefore, strict infection control procedures have to applied. Dental authorities and governing bodies publish guidelines on this subject which have continually to be amended due to the ever changing nature of infectious diseases and the discovery of new diseases. By adhering to these guidelines, the dental team can minimise the risk to both themselves and their patients.

From the information presented it would certainly seem to be true that "an ounce of prevention is worth a pound of cure".

PART II

UNIVERSAL PRECAUTIONS ACCORDING TO PUBLISHED GUIDELINES

The purpose of infection control is to reduce the number of microbes being shared between people (Miller, 1996). Since the mid-1980s, when the impact of AIDS was fully realised, infection control has become an integral part of the duties of those working within a range of health care settings. For dental health care workers, governing bodies and dental authorities have put together guidelines concerning the measures which should be taken within the dental surgery. Implementing and maintaining a high calibre infection control programme may be difficult, particularly in assuring that it is compromised neither by a sense of complacency nor by a sub-standard level of knowledge. To avoid this, due attention must be paid to infection control at all times and periodic reassessments of the programme must be made to ensure it is up-to-date and that the level of concern and awareness of the practice staff is maintained.

Numerous guidelines have been published in relation to dental infection control and, indeed, many other aspects of health care. But how do guidelines come about? According to McComb *et al.* (1997), guidelines concerning dentistry should be based on reliable scientific evidence, along with a significant input by dentists themselves who can offer their practical knowledge. The validity of such guidelines is confirmed 'when they lead to the health gains and costs predicted for them' (Eccles *et al.*, 1996).

Established in 1993, The Scottish Intercollegiate Guidelines Network (SIGN) was devised to sponsor and support evidence-based clinical guideline development for the NHS in Scotland. According to SIGN, the development process hinges very much on the selection of the topic as this dictates the changes that are desired (SIGN, 1999). The

composition of the guideline development panel and its work, the identification and assessment of the literature and the method of guideline development will determine the effectiveness of the guideline(s) produced (Eccles *et al.*, 1996). For the systematic and unbiased development of guidelines, systematic methodology akin to that of a systematic review should be applied in order to offer an effective set of guidelines based on a reliable synthesis of the findings (Grimshaw *et al.*, 1995). In 1995, Grimshaw and his colleagues considered that assessment of the evidence should be based on the methodological quality of the research design employed rather than on the 'applicability of the evidence'. However, as Kay & Locker (1996) suggested, randomised controlled trials, which are considered the gold standard of research design, are the exception rather than the rule in the field of dentistry and therefore a mixture of evidence is required for the development of recommendations. It should be remembered, nevertheless, that guidelines are of no use if they appear groundbreaking on paper but impossible to implement in the dental surgery.

Thomson (1999) discussed the dissemination and implementation of guidelines, two critical areas of the process which often receive little attention. Yet these are the stages that are the most crucial if the process is to have been worthwhile. Grimshaw & Russell (1994) stated that guidelines are likely to receive greater implementation if disseminated as an educational initiative but less if simply published in a journal. The guidelines' success will depend on the audience to which they are made available. Audits can prove worthwhile in this area as the implementation and compliance with guidelines can be monitored and ways of improving implementation highlighted (Thomson, 1999).

It is clear that the development of guidelines is a process fraught with potential pitfalls and bias. In response to this, Cluzeau *et al.* (1999) developed a generic critical appraisal instrument with the hope that policy makers could use it to assess 'the rigour of development, the clarity of presentation and the implementation issues' relating to guidelines. Cluzeau and her colleagues tested this tool on sample guidelines for the management of asthma, breast cancer, depression and coronary heart disease with a total of 120 appraisers. The internal consistency of the measure was assessed using Cronbach's α coefficient to ensure that the items of which the measure was composed correlated well with one another. The measurement tool was found to be reliable and offers a means of assessing guidelines in their preliminary stages and each time they are amended, which clearly may be of great benefit in the field of health care.

The application of guidelines and recommendations in the area of dental infection control is common place and, as a result, difficult to monitor. Due to the asymptomatic nature of many infectious diseases in their early stages, those individuals who are infected may not be aware of their condition and therefore not in a position to inform their dentist. As a result, the principal guideline in place in dental infection control today is **to treat all patients as potentially infectious** (CDC, 1985). By applying the ultimate infection control procedures for all patients, the risk of cross infection can be minimised for both staff and patients. Furthermore, an equal standard for all patients means that all members of the dental team should be aware of the practical requirements.

Each practice nowadays is advised to have its own infection control policy in a written form. Advice on the development of an infection control programme specific to each practice has been published by Sprouls (1994). The orthodontic practice, for example, requires such a policy due to the associated high risk of cross infection (Mulick, 1986). An infection control policy will map out the barrier measures which should be used in the surgery, immunisation of clinical personnel, systematic processing, sterilising, storage and use of instruments, a disinfection regime, the correct disposal of clinical waste and sharps, a safe and effective post-exposure follow-up and details of staff training. These aspects of infection control are presented in more detail below.

- **Barrier Techniques**

The hands of the dentist, hygienist and often the dental surgery assistant form the first route of potential cross infection. Before donning gloves, handwashing with an antibacterial handwashing agent is advised to remove microbial flora on the skin and also to reduce the likelihood of skin irritation resulting from the waste products of bacterial growth which can occur under gloves. The use of gloves by dental health care workers has been encouraged since 1985 (CDC, 1985) and the BDA has recommended that good quality non-sterile gloves are worn and that these comply with European Standard BS EN 455. Recommendations on glove wearing have since been amended to include the changing of gloves between patients. This amendment was made as it became obvious that washing gloves between patients with soap or detergents may be compromising the effectiveness of the infection control measure (Adams *et al.*, 1992; Bagg *et al.*, 1990). Evidence suggested that washing could affect the chemical properties of the latex, thus

reducing its protective capacity. By altering the material, puncture wounds and piercing of the gloves could occur more easily (Miller & Palenik, 1998). However, the increased risk also applied to the patient, as simple washing could not guarantee sterilisation of infectious contaminants (Adams *et al.*, 1992). The changing of gloves by dentists only when torn or visibly stained was unacceptable and an amendment was clearly needed.

Hypersensitivity to disposable latex gloves is a growing concern for many of the dental team. The issue came to a head in the early 1990s when the Food and Drug Administration (FDA, 1991) announced a special alert as a consequence of fatalities related to latex allergy. Varying degrees of adverse reaction have been noted amongst dentists. Contact dermatitis is a chronic inflammatory reaction which can be delayed for up to 24 to 72 hours. Wheal and flare reactions produce localised oedema while, at the opposite end of the spectrum, anaphylactic shock can result from contact with certain allergens and presents itself very quickly. It is this type of reaction which puts people in the most immediate danger. These allergic reactions stem from the natural latex proteins which are present in gloves, the elastic bands of masks and rubber dam. The water-soluble proteins may leak out and directly contact the skin as the wearer perspires. Alternatively, they can adhere to corn starch particles present inside and outside the gloves or be suspended in the air (Miller & Palenik, 1998).

In order to combat this problem, allergy sufferers have been advised to use non-latex, hypoallergenic gloves, but due to the hot and moist conditions inside the gloves, reactions can persist. Manufacturers have also tried to reduce the allergenic potential of the

products in answer to this problem. Moves have gone as far as to set up a Latex Allergy Support Group. Louise Perrin, the chairperson of the group, had to abandon her career in clinical dentistry due to the scale of her allergy and has since founded this support group for others facing a similar situation. (Perrin, 1997).

Gloves are only one of several barrier measures employed by the dental team in their battle against cross infection and should be seen by patients to be worn in order to allay any fears they may have (Lindsay, 1992). Gloves protect against direct skin contamination via the hands of the DHCW, but masks and protective eyewear protect against aerosol and spatter contamination. During invasive dental treatment, saliva and blood can often disperse into the air posing a threat for the dental team if inhaled or if contact is made with mucous membranes of the eyes, nose or mouth. Therefore a mask should be worn during treatment and changed regularly. It may at first seem unnecessary to change the mask frequently but tests have shown that over time the material becomes porous due to condensation and particles from the air may be able to penetrate the material. It has therefore been recommended that a mask is changed after 20 minutes in aerosol conditions and 60 minutes in non-aerosol conditions (Miller, 1996).

Protection of the eyes is equally important during operative dentistry. Many dentists and hygienists, the groups of DHCWs who have the greatest amount of contact with patients, wear corrective spectacles for medical reasons but these also serve as protection in the dental surgery. For those people who do not, protective glasses are available, as are face

shields. These protect the eyes from spatter from the side with their curved edges. Patients should also be offered glasses to protect their eyes from physical injury.

It would seem illogical for DHCWs to take all these precautions but fail to cover their own clothes with a protective layer. As was obvious from the results of a study by Austin *et al.* (1991), only 51% of female dentists surveyed in the four American states of Texas, California, New York and Illinois wore a lab coat or protective garment for reasons of infection control. They instead felt that the coat created a professional image. The garments used should be disposable or, if reusable, should be laundered to 65°C on the premises or by a professional laundry service to ensure eradication of any potentially infectious matter. The BDA Advice Sheet A12 (1996) commented on the use of short or long sleeved garments, each of which have their disadvantages. On the one hand, short sleeves leave the operator's skin unprotected and any broken skin or abrasions uncovered but, on the other hand, long sleeves may come into contact with the skin surrounding the patients' mouth and as the coat is not normally changed throughout the day, infectious particles could be passed in effect from one patient to another. No recommendation was made either way but is an issue which needs to be addressed.

Although often overlooked, rubber dam is a significant barrier measure for the dental team (Marshall, 1995). Rubber dam is a piece of equipment which can be placed in the patient's mouth to isolate the tooth or area being treated. From the view point of infection control, its main purpose is to reduce the risk of salivary contamination of the operatory area but also to reduce contact with saliva and blood spatter or aerosols which can be

dispersed into the air during treatment. It is important that high speed aspiration is applied when using rubber dam as saliva and blood can build up quickly in a very defined area. Each of these measures offers a barrier between the dental team member and any infectious material. By creating a layer or line of defence, the risk can be reduced.

- **Immunisation**

Since the introduction of the hepatitis B vaccine in the mid-1980s, all health care workers have been encouraged to take this precaution. In dentistry, primarily dentists were targeted, as they were thought of as the first line of contact, but in recent years it has become obvious that all staff with clinical contact need to be protected. In the US, dentists now have the responsibility to provide immunisation for their staff – free of charge. This is an indication of the universal nature of infection control today.

The hepatitis B vaccine, composed of hepatitis B surface antigen, can exert a protective effect for those individuals who develop antibodies to the surface antigen (Anti-HBs). Three doses of the vaccine are given: at baseline, after one month and again after 6 months. Follow-up to the vaccine should take place 2-4 months after completion of the vaccine course in order to evaluate antibody levels in the blood (Chartres, 1995). An alternative 'rapid' immunisation programme sets the dates for second and third doses at one month and two months with a booster dose at 12 months. Although this opportunity is given to protect oneself from hepatitis B infection, the vaccination alone is not sufficient action. Many people are unaware that the acquired immunity provided by the vaccine may not be lifelong, and present recommendations are that it should be bolstered

approximately every five years for the majority of people. Educating of dental personnel regarding follow-up to immunisation is therefore required and suggested by the numerous sets of guidelines available. Sufficient response and immunity conferred by the vaccine is marked at 100 miu/ml. In America, revaccination is not called for if the individual reaches more than 10 miu/ml antibody level after the first course of vaccine (Samaranayake, 1995). If one sustains an occupational injury, a booster dose may be required.

However, not everyone responds to the vaccine – some are true non-responders, others have been infected at some stage but have since eliminated it from their bodies (natural immunity) and there are those people who are carriers of the virus. Further tests of non-responders should be performed to identify carriers of HBe antigen who pose a particularly high risk to patients. Other non-responders to the vaccine should be particularly conscientious in seeking follow-up testing.

- **Sterilisation**

Another risk-reducing procedure applied throughout the health care profession is the sterilisation of instruments. Within the dental sphere, this includes the sterilisation of hand instruments, dental syringes and, more recently, handpieces. Guidelines clearly specify the process to which these items should be subjected. Key steps in the sterilisation process are commonly referred to in infection control practice policies. Beginning with a pre-soak, the items should then be cleaned, using heavy duty gloves for hand protection, rinsed, dried, sterilised, dried again and then stored in aseptic conditions.

Ultrasonic cleaning may be preferred for the initial treatment of the instruments. The instruments are placed in the solution for 2-10 minutes and, in so doing, the blood and saliva rinse off before being allowed to dry (Miller, 1996). This type of mechanical cleaning minimises exposure to potential contaminants as it replaces 'hand scrubbing'.

There are four principal methods of sterilisation available to the dental team – autoclaving, chemical vapour and two forms of dry heat sterilisation. For each treatment the items can be placed in sterilising bags but there is evidence both for and against this strategy. In the UK, the Department of Health does not recommend bagging of instruments in a downward displacement autoclave. The first, and most widely used method, is the steam sterilisation method. Allowing the steam to move freely, an autoclave runs for 20-30 minute cycles at 121°C or at 134°C for 2-10 minutes. These figures can vary according to specific guidelines. Although the autoclave is the preferred method for hand instrument sterilisation, one has to be aware of the possibility of air layering, as air is heavier than steam, and air pocketing both of which can prevent steam from coming into contact with the entire load and reducing killing of the potentially infectious agents. Repeated use of this method can also damage the instruments: hard water can mark instruments; plastic or rubber reusable items can suffer damage; the water can corrode carbon steel items. Sterilising bags can also be wet due to the steam.

Sterilisation by unsaturated chemical vapour running for 20 minutes at 134°C can similarly cause damage to rubber or plastic instruments. However, no corrosion of carbon steel items has been noted and the bags remain dry. This particular method, more popular

in the USA than the UK, requires the purchase of a special solution. Dry heat ovens are the third option for sterilising purposes. The oven functions at 160°C for as long as two hours. The extreme heat can damage rubber and plastic items but the dry air means that little or no corrosion of the carbon steel instruments occurs and the packs remain dry. This is likewise the case for the fourth and final method of heat treatment which relies on dry heat but is based on rapid heat transfer. This technique requires a temperature of 191°C to be reached and sustained for 6-12 minutes if it is to be effective. The detrimental effects are similar to those when using a hot air oven but the advantage is that this method involves a fairly short cycle.

Each method varies in terms of the form of heat treatment used. Whether steam, chemical vapour or dry heat, the sterilising agent must have sufficient access to the instruments for circulation to be possible and a positive cycle to be run. For the sterilisation of certain items, a less aggressive methodology has to be used. Rubber dam, x-ray positioning rings, rulers and orthodontic debonding guns, for example, need to be sterilised following use due to their potential contact with body fluids. Their composition, however, does not allow them to be treated at such extreme temperatures and instead chemical sterilants are used. Sterilants such as radiation, gas plasma hydrogen peroxide and ethylene oxide gas could be used in this situation but their cost is a deterrent in many situations.

The alternative comes in the form of liquid sterilants which, at room temperature, do not provide sterilisation, only disinfection. The list of drawbacks to this technique is long. Their toxicity and irritant potential can cause problems for the user and demand suitable

storage, ventilation and protective equipment according to COSHH regulations. Solutions such as glutaraldehyde are toxic and protection from splashes and vapour is therefore essential. Preparation of the solution, periodic monitoring of the concentration levels of the solution, a 10 hour submersion period, thorough rinsing, aseptic processing and appropriate packaging make this a time consuming procedure.

Efficient monitoring of these sterilisation procedures is at the centre of infection control. Periodic checks ensure that the equipment is functioning properly and that the instruments are successfully sterilised for re-use. This task is to be carried out on a regular basis, according to related guidelines. Several measures of efficiency exist: physical, chemical and biological. Physical indicators refer to the dials and gauges of an autoclave or other steriliser and aim to test whether they present accurate or false readings. Chemical indicators involve heat sensitive inks which change colour when a specific temperature or time or combination of these two factors is achieved. An example of a chemical indicator is the arrow symbol which appears on the reverse side of sterilising bags. Biological indicators come in two forms and measure whether highly resistant bacterial spores have been killed.

1. The spore strip is held in a protective glassine envelope while deposited in the steriliser and allowed to run for a cycle. The strip is then removed aseptically from the sleeve and deposited in a tube of growth medium. The contents are incubated at 55°C for 7 days and if vegetative bacteria grow, this is an indication of sterilisation failure.

2. The self-contained spore test works on a similar premise. A strip is held inside a plastic vial with a vented cap holding an ampoule of growth medium. The tube is placed in the steriliser and after completion of the cycle the tube is snapped shut to break the inner vial, mixing the growth medium with the strip. If after incubation at 55°C for at least 2 days a colour change may take place which highlights insufficient sterilisation.

Recommendations for handpiece sterilisation became commonplace in 1986 as it became clear that various forms of microbes could be passed from patient to patient by this route. Changes were then made to these recommendations in 1992 when the American Dental Association (ADA) stated that, using acceptable methods (which according to the CDC was heat processing), every effort should be made to sterilise handpieces **between** patients. The CDC and Canadian Dental Association (CDA) also suggested that anti-retraction valves be fitted to handpieces in order that no contaminants are sucked into the handpiece itself and that the discharge of water and air is possible following the treatment of each patient for 20-30 seconds at a time. Although no cases of transmission via the handpiece have been reported, Epstein *et al.* (1996) reported that the risk is real and preventive action is the best solution.

The issue of handpiece sterilisation has provoked a great deal of controversy during recent years due to the increased financial costs incurred by the dentist as a result of related guidelines, as well as the significant encroachment these recommendations have made on time available to dental practitioners for the use and sterilisation of handpieces.

Shovelton *et al.* (1984) made the suggestion that, although buying more handpieces at the outset means a larger initial outlay, it is financially more viable in the long term. Sterilisation can put added wear and tear on handpieces and is thought to have a detrimental effect on their functionality, but Shovelton *et al.* (1984) believes that circulating a greater number of handpieces means that each one is put under less strain and their life span increased. Attempts by manufacturers to ease these difficulties have reduced the degree of damage inflicted.

- **Disposable items**

The advent of infection control has seen the gradual introduction of disposable items into dentistry. Their purpose is twofold – to minimise the risk to patients of cross contamination and to reduce the impracticalities that sterilisation and disinfection can pose in a busy dental practice. One would hope that it goes without saying that all local anaesthetic needles and cartridges are not to be re-used. Disposable options of paper towels, water cups, 3 in 1 tips, aspirator tips, saliva ejectors, impression trays and certain instruments including burs, scalpels and matrix bands (BDA Advice Sheet A12, 1996) are now on the market and recommended by dental authorities. When considering use of such items, the advantages of cross infection prevention are often weighted against the disadvantages of increased costs and wastage.

- **Disinfection**

Disinfection is required for areas within the dental surgery which are unable to be sterilised but which are at risk of becoming contaminated. The suggestion of having cross infection control-determined surgery design was reported in a publication by Rothwell & Dinsdale (1988). They suggested 'zoning' the surgery into clean and unclean areas and, in so doing, isolating contamination to certain parts of the surgery. The need for change was obvious, as infection control has become more prominent in people's minds. Following Rothwell and Dinsdale's publication, idealistic suggestions were made as to the design of the surgery (Worthington *et al.*, 1988), but clearly the layout of the building will not always allow this. BDA Advice Sheet A12 (1996) recommended that two areas be in operation, one for the dentist or hygienist and a second for the dental assistant in order to prevent ancillary tasks being performed in close proximity to clinical procedures.

Surfaces, which are at risk of becoming contaminated, clearly have to be disinfected. In doing so, it is advised that they be cleaned once with disinfectant and a second time to ensure asepsis. The disinfectant used should be registered for this use. It should also be registered with the Environmental Protection Agency and be highly stringent and labelled tuberculocidal, bacteriocidal and virucidal to ensure microbes are killed, according to BDA recommendations.

The alternative is to cover surfaces and prevent them from coming into contact with potentially contaminated substances and simply change the surface cover. This is often the best idea for areas which are particularly difficult to clean. These may include air-

water syringe buttons, dental light handles, chair switches, bracket-table handles, sink taps, electrical toggle switches and buttons, curing light equipment and difficult to reach areas. Ideally, the surgery floor will be covered with an easy to clean, non-slip surface. Seam free wall/floor joins and wall/worktop joins would curtail those hard to reach areas and dental chair design has now been modified with infection control in mind so as to make the disinfection process easier.

Action has to be taken to eliminate microbes from surface areas but also from the air. A mechanical system to re-circulate the air is an expensive investment but a very effective one if maintained, cleaned and regularly tested. The re-filtration of air removes any impurities but the external discharge sites should be positioned so they are of no risk to the public. Good ventilation, high speed aspiration and externalising of potential contaminants can reduce the risk of infection by aerosols.

Another source of potential infection emanates from the waterlines which provide the handpiece with water and which is included in disinfection recommendations. The waterlines which feed the handpieces and air-water syringes can be host to both oral and environmental bacteria. Biofilms containing such micro-organisms coat the inside of the lines. Suggestions have been made that flushing the waterlines with water at the beginning of a session, between patients and again at the end of a session for twenty seconds will reduce the number of bacteria present. The BDA go one step further by recommending that to rid the waterlines of bacteria, one should flush the waterlines with a detergent like hypochlorite solution (BDA Advice Sheet A12, 1996). In contrast to this,

the CDC believes that flushing the lines may in fact increase microbial contamination by simply dislodging any bacteria (Williams *et al.*, 1996). They suggested instead that the handpiece be removed and the lines allowed to run for several minutes before each session. In 1993, the CDC went on to state that water and air should be discharged for 20-30 seconds following each patient. As an alternative to these approaches, a bacteria filter could be fitted in the waterline leading to the handpiece and air-water syringe or a clear water system which would bypass the problem area altogether, guaranteeing clean water.

One source of potential transmission which is often overlooked is that of impression disinfection. As is the case with any substance which comes into contact with body fluids, impressions should be subjected to a strict disinfection regime. After rinsing the impression and removing saliva and any blood or debris, the impression (or other prosthodontic or orthodontic appliances) should be disinfected for at least 10 minutes in a suitable disinfectant which will be microbicidal without altering the properties of the material. Strassler (1991) reported that the most commonly used disinfectants are iodophors for a range of appliances and impressions of different materials (acrylic, metal, porcelain). Glutaraldehyde is a highly toxic disinfectant and should not be used. The disinfectants used for this purpose should always be stored safely and labelled clearly. The appropriate protection should be taken when using these materials.

Radiography is another aspect of dentistry where the potential for cross infection is not fully noted. However, related guidelines are now in place and recommend that the x-ray equipment be cleaned or covered, as should the packs which are placed in patients'

mouths. When the X-ray has been taken, the developing process begins and despite the fact that the contaminants on the x-ray will have been reduced, the solutions used should be regularly changed in order to minimise risk. The disinfection of objects and areas not able to be sterilised is endless. This reflects the true potential for cross infection within the surgery. Guidelines pertaining to disinfection clearly stipulate those areas which require most attention and, no doubt, will be added to in the years to come.

- **Clinical waste and sharps disposal**

The appropriate and safe disposal of clinical waste and sharps from the dental surgery is crucial. This is a further stage at which the general public can be put in danger if the infection control procedures are not carried out properly. All waste should be determined clinical or nonclinical. According to the BDA, clinical waste is waste contaminated with blood, saliva or other body fluids (BDA Advice Sheet A12, 1996). OSHA's definition is more precise, stating that liquid blood or saliva, sharps contaminated with blood or saliva, nonsharp solid waste saturated with liquid or semisolid blood, saliva or tissue including teeth should be considered clinical waste (OSHA Standards and Indiana Laws on Infection Control, January, 1993).

Guidelines state that all sharps, which would include used needles, parts of instruments or any other sharp object, be disposed of in puncture-resistant boxes and be collected by a recognised refuse service. Dentists should make sure that the boxes are not filled more than two thirds full. All clinical waste should likewise be collected by a professional refuse company in appropriately strengthened bags for clinical waste with the nature of

the contents clearly marked and displaying a biohazard label. Signing by both parties indicates that the waste will be disposed of in an appropriate manner i.e. not at local refuse tips. Dentists who fail to adhere to these guidelines can face legal action in the UK by the Environmental Health Department, the H&S Executive and the GDC.

Any items leaving the dental surgery by post should similarly undergo the standard sterilisation procedure. Biopsy specimens, orthodontic or prosthodontic appliances should be sealed securely, wrapped in absorbent material, placed in a plastic bag and padded envelope before being clearly marked as 'pathological specimen – fragile, handle with care' and marked with the sender's name and address. First class letter post or data post services should be used.

- **Occupational exposure**

Occupationally acquired injuries were a common occurrence in many dental surgeries for years but it is only during this age of infection control that the dangers involved have been fully realised. Exposure to a variety of bloodborne infectious diseases can be defined by a contaminated object, be it a used needle or instrument, breaching the integrity of the skin or contacting mucous membranes. Injuries can include sticking oneself with a used needle or instrument, splashing one's eye or an open lesion with a contaminated substance, sustaining cuts from used equipment and bites or scratches inflicted by patients, according to BDA definitions. Cleveland *et al.* (1997) demonstrated a steady decline in the number of percutaneous exposures during the last ten years in the US. Having brought the danger involved to the forefront, dentists and other members of

the dental team are now aware of the risk and are taking steps to reduce the chance of injuries occurring. However, the rate of injuries is far from ideal and safer instrumentation and work practices need to be investigated (Cleveland *et al.*, 1997).

Evidence has been published suggesting that certain behaviours are putting dental team members at risk, for example, the resheathing of needles. Safety provision could be improved according to Cuny & Carpenter (1998) for although resheathing devices are available, not all DHCWs use them as they perhaps have a routine procedure which they have used for years and are not willing to change or they feel that it will impinge on their time. In this respect, prevention is the area to be focused on, as this will eliminate the need for explicit post-exposure protocol, but as the rate remains far from ideal, key recommendations are in place for those who do suffer an injury.

Each practice should possess an 'accident book' in which every incident is recorded. This will serve as evidence if transmission does occur. The DHCW should seek immediate medical testing to record a baseline reading of their HBV or HIV status. If the patient involved is known to be HIV positive, the medical supervisor will consider the situation and decide whether to administer post-exposure prophylaxis (UK Department of Health, June 1997). A doctor needs to consider such factors as the cost of prescribing drugs such as zidovudine (ZDV), lamivudine (3TC) and indinavir, as well as the emotional impact of the event and the nature of the injury. The response should be immediate as drug therapy can only have an effect if given within hours of the injury occurring.

- **Staff training**

The education of all dental team members is vital if the chain of infection control is to remain effective and intact. The need for continuous staff training has been increasingly recognised in recent years. Both external education, in the form of specialised postgraduate courses, and 'in practice training' can only benefit the safe and efficient running of the practice in the long term. At the most basic level, all staff should be familiar with the current infection control policy of the practice and should be able to answer any questions the public may ask in relation to this. Roth (1996) believes that patients should also be educated about infection control, thereby increasing their satisfaction, reducing their anxiety and benefiting patient referrals. A good understanding of infectious diseases and the potential routes of transmission forms the crux of appropriate infection control behaviour. It is this knowledge which will rationalise the need for personal protective equipment and the need for a sound understanding of all infection control protocols.

The importance attached to infection control has been demonstrated in the scientific literature at both local and national levels. For example, Davis & Wistanley (1997) reported on the successful implementation of dental team education within the Restorative Dentistry Department at the University of Sheffield, UK. At a national level, continuing moves are being made to set up collaborative services for the dissemination of educational initiatives to HCWs in general. These include the International State-of-the-Art HIV Clinical Conference Call Services, whose quarterly audio teleconferences allow cost effective discussion of related issues according to the needs highlighted by primary

care givers (Macher *et al.*, 1994). A number of AIDS Education and Training Centres funded by the Health Resources and Services Administration (HSRA) have also been set up in America to offer both theoretical and clinical training. In 1993, a subcommittee of the HRSA formed an AIDS Advisory Committee which acts as the interface between research and practice. Their interpretation of study results provides primary care givers from a variety of health care fields with a better idea of the implications of these findings. The HIV Telephone Consultation Service jointly funded by the HRSA, the American Academy of Family Physicians and the National Institute of Health offers advice and support to HCWs who have questions with regard to HIV clinical management. These services are an indication of the recognition by government-related bodies of the problems facing HCWs and the important role that education has to play in the area of infection control.

- **The cost of infection control**

The phasing in of infection control has resulted in increased costs for dentists. With scientific progress, more and more precautions are being recommended, adding to the costs each time. This increase has to be accounted for and in some US practices dentists have imposed an infection control fee (Roth, 1996). The necessary supplies, staff training, sterilisation equipment, handpieces and housekeeping all contribute to these increased costs. Therefore it is not surprising that an American survey revealed that dental economy was uppermost in the minds of 76% of responding dentists (Nash, 1992). The ADA likewise wanted to investigate the effect new guidelines had had on the financial situation of US dentists. From a random selection, 35% of dentists responded

and in the final report entitled 'Survey of infection control and OSHA compliance costs', it was illustrated that added infection control costs were directly related to guideline compliance (Feldman & Bramson, 1994). 79% of dentists reported increasing individual procedure fees while 8% introduced a separate infection control fee, as Roth (1996) suggested, specifically in chronic critical care shortage areas and in high poverty areas.

- **Law and Ethics**

Infection control is engulfed by ethical and legal implications. When an infected patient presents for treatment and discloses his/her status as a carrier of a blood borne virus, the dental team has an obligation to treat this individual, as they have a 'service to the public' (Davis, 1989), unless the necessary facilities are not available to them in which case referral to another practice is acceptable. Otherwise, ethics dictate that an infected patient has an equal right to treatment as any other member of the public. Even more reason for offering treatment is the fact that many infectious diseases manifest themselves primarily in the mouth and therefore the first signs of disease may be detectable by the dental team. Early detection means early referral for medical advice, testing, supervision and counselling which is not only good from the point of view of prognosis and treatments available but also as the patient will be aware of his health status and may act accordingly. Refusing to treat infected patients is not only unethical but irrational, as potentially infected patients pass undetected through the door of the surgery every day (BDA, June 1996) and the evidence indicates that the risk of transmission is low (Geddes, 1986). By using standard infection control precautions for all patients the dentist is indicating his faith in the effectiveness of such precautions.

Patients have the right to chose whether to disclose medical information, but every effort should be made by the dentist to take a full medical history and any information disclosed has to be treated as strictly confidential by both the dentist and the team. A dentist is not only ethically bound to treat infected patients but also obliged to seek medical advice and testing if thought to be potentially infectious themselves. The dentist may have to discontinue practising or exclude exposure prone procedures from their practices - 'those where there is a risk that injury to the worker may result in the exposure of the patient's open tissues to the blood of the worker' (UK Department of Health, March 1994). HBe antigen positive dentists are not permitted to remain in practice. As Corless (1992) made clear, the AMA and ADA also require any HIV antibody positive dental personnel to refrain from performing these invasive procedures.

From a legal perspective, refusal to treat a patient on the grounds of medical status is reprehensible under the Disability Discrimination Act 1995. Failure by a dentist to take the appropriate precautions in the dental surgery to minimise the risk of the spread of pathogens from dentist to patient or from patient to patient is considered breaking the law (Health and Safety at Work Act 1974). Under the NHS (General Dental Services) Regulations 1992 and NHS (Service Committees Tribunal) Regulation 1996, failure to comply with key infection control measures can result in disciplinary action and, in serious cases, interim suspension will be imposed until the date of the tribunal.

Laws also exist in relation to the correct disposal of clinical waste (Environmental Protection Act 1990) with the dentist being responsible for this. Control of Substances

Hazardous to Health Regulations (1994) refer to the assessment of the substances used within the dental surgery, making plain that potentially hazardous agents are either avoided or suitably stored. The health and safety of employees is obviously paramount and Management of Health and Safety at Work Regulations (1992) are in place in order to ensure that appropriate risk assessment is carried out in each surgery. This involves the dental team keeping track of any potential hazards, the people who may be at risk, evaluating the risks, recording the findings and periodic reassessment (BDA Advice Sheet A12, 1996).

PART III

THE TECHNIQUE OF SYSTEMATIC REVIEWING

Systematic reviewing is a relatively new scientific technique, employed principally to make sense of large, unmanageable amounts of information. Thousands of scientific papers are published each year in all areas of research and this is one means of easing the process for people such as health care professionals, consumers, researchers and policy makers working within the health profession (Mulrow, 1994). Systematic reviews can offer a clear and concise summary of the primary research to date for decisions in health care while enabling readers to familiarise themselves with research in fields other than their own.

Traditionally, reviews have attempted to summarise the literature available relating to a particular research topic and to draw comparisons between the results of different studies, offering possible explanations for the findings. The weaknesses of such an approach are apparent and have been noted by researchers (Deeks, 1998). The haphazard nature of the methodology could mean that two reviews carried out simultaneously on the same research question but by different authors could easily produce two quite different sets of conclusions. In addition, there is the danger that the review will become a manifestation of the authors' opinions rather than a true reflection of the evidence. In order to address these problems the technique of **systematic reviewing** was introduced.

Systematic reviews are based on clear and precise methodology. They are carried out according to a clear format to assure that a standard strategy is taken, that each review will consist of the same elements and that the reliability of the findings will be consistent across reviews. The systematic review filters out the insignificant studies and pinpoints

the essential ones that will offer worthwhile and reliable findings, with a view to meeting the primary objectives of each review (Chalmers & Altman, 1995). In doing so, one is able to determine the accuracy of the conclusions presented in each scientific study, which can often be taken for granted following publication. Integration of the selected studies results in the synthesis of the findings to produce an overall summary of the literature available in that field. Considering the most reliable studies, an assessment can be made of the consistency of the findings and their generalisability across settings, according to different definitions of the disease, different forms of treatment and varying methods of measurement.

In terms of research, systematic reviews allow key areas for future research to be highlighted as well as those areas which have been studied sufficiently and require no further investigation. Ultimately, such a review is less costly than a new study. In terms of practice, systematic reviews can maximise health care decisions, offering the health care profession up-to-date, reliable conclusions regarding a range of health care issues. This will improve the situation for both the professional and the patient.

The systematic review is becoming an attractive alternative option for these reasons.

According to Deeks (1998), several types of systematic review exist which include:

1) Bibliographic or qualitative reviews - this first type of review examines studies assessed as being of the highest quality available in the research field but due to

variability in the settings, interventions or outcomes, a mathematical synthesis of the results is not possible. This type of review is often applied to the most complex problems as it allows an overall impression of the research to be gained and intricate details to be teased out.

2) Reviews of effectiveness - this alternative type of review aims to evaluate the effectiveness of an intervention by performing statistical analyses of the data. This quantitative approach is also known as a meta-analysis.

3) Methodological reviews – attention is focused in such a review on the type of research design used to assess the efficacy of the intervention in question or the application of a specific method of analysis.

The profile of systematic reviews has been heightened considerably by the continuing expansion of the Cochrane Collaboration. This international organisation was founded following the comments of a British epidemiologist, Archie Cochrane. Cochrane recognised the fact that traditional reviews offered little to the world of research. As they stood, reviews compromised the health care service, as they were neither reliable nor sufficiently updated to allow well-informed decisions to be made. Changes were needed, namely that a standard methodology be imposed and the reviews be up-dated as new evidence becomes available (Mulrow, 1987).

Cochrane's call for systematic and up-to-date reviews was initially taken onboard by the Research and Development Programme, which came under the auspices of the National Health Service in the United Kingdom. Funds were provided by the NHS for the first 'Cochrane Centre' in October 1992, the principal function of which was to facilitate systematic reviews of randomised controlled trials from all areas of health care. Initial hopes for collaborative work in this area were confirmed a year later in October 1993 when representatives from eleven countries amalgamated to found the 'Cochrane Collaboration'.

The Collaboration comprises several branches each of which specialise in a clinical area. For example, the Cochrane Oral Health Group has recently been set up to encourage reviews within the dental and oral medical professions. The organisation aims to help people to make informed decisions about health care by preparing and maintaining accessibility to systematic reviews of the effects of health care interventions. By developing universal methodology for systematic reviews, efforts can be made collaboratively by researchers world-wide on any project as all researchers will be aware of the standard framework. Furthermore, the Collaboration aims to improve the methods of dissemination of the findings arising from each review. These aims can best be achieved by following the nine principles: collaboration, building on the enthusiasm of individuals, avoiding duplication, minimising bias, keeping up to date, ensuring relevance, ensuring access, continually improving quality of its work, continuity.

The preparation of a systematic review is paramount. It requires considerable time and effort as this forethought will lay the foundations for the later stages of the review. Many decisions have to be made before the actual review process begins: consideration of the search strategy, the inclusion criteria and analysis of the data. On the one hand, a clear strategy is required with each methodological element well defined but on the other hand, a practical perspective has to be taken, as ideal methods are not always possible. The intentions of the researchers are noted in the protocol, but as is often the case, circumstances arise which prevent things from going according to plan. For this reason, a certain degree of manoeuvrability must be maintained and any changes should be reported in the review to inform the reader of every piece of information. However, under no circumstances, should the protocol be altered on the basis of the results, as this would undermine the very essence of a systematic review (CRD, January 1996). Depending on the type of data under analysis, 'sensitivity analyses' can be performed to determine the effect, if any, that these protocol changes will have had on the overall results. The standard methodology applied to systematic reviews varies only by the terminology used by different research groups. The methodology comprises key elements, each of which are described below.

1. DEFINING THE TOPIC

Clear definition of the review topic is essential as this will limit the research to a key area, facilitating decisions about other review elements such as the search strategy and the inclusion criteria. By forming a focused definition, a great deal of time can be saved further on in the review process (Chalmers & Altman, 1995).

2. OBJECTIVES

The objectives of the review need to be well defined as the entire review will be shaped according to these.

3. SEARCH

As the purpose of a systematic review is to draw together all the research pertaining to the topic at hand and to offer conclusions, the search for relevant studies has to be sufficiently extensive to account for all possible research. An ideal systematic review will uncover all related studies whose quality can then be assessed. To do so, several methods of searching should be employed.

Published literature: Numerous electronic databases are now available and hold the details of scientific papers which have been published. Rigorous searching of these databases is required to assure accountability of all possible data relating to the review's objectives. These databases, however, vary on a number of measures. A) Specific databases hold information for specific fields of research and the appropriate ones should be accessed. For example, EMBASE (Excerpta Medica online) is a largely pharmaceutical-based database and may prove fruitless for people carrying out a review of a topic which is not directly related. With the same token, this is not to say that relevant papers will **not** appear on this database. Therefore time saving exercises can often run the risk of missing potential studies. B) Electronic databases also differ from one another in terms of the origin of the material and language specificity. For example, certain databases deal only with European research while others specialise in American-

based literature. For this reason, if a world-wide review is the objective and one is imposing no language restrictions then such a limitation must be taken into account. C) Often systematic reviews are carried out over many months, sometimes years, therefore current awareness searches are an effective means of updating one's register of studies to stay abreast of the latest developments in the field. They also allow recently published studies to be incorporated into the review, producing a comprehensive and 'up-to-the minute' review of the evidence. As different databases are updated at varying rates, ongoing searches of **several** databases would be required to ensure new studies are captured.

Unpublished literature: Material not yet published is equally important when carrying out a systematic review as the findings may have a considerable effect on the overall conclusions of the review, particularly if the research is recent, having built on the results of previous work. Databases have now been compiled which deal specifically with 'grey literature', as it is referred to in Europe, and 'black literature', as it is known in the United States. Both types of databases' studies are indexed according to keywords which have been selected by the authors of each paper. As no standard rules or methods of indexing have been implemented, studies can often be missed if selected keywords do not correspond with those chosen by the systematic reviewer for inclusion in the search strategy. This problem is one that needs to be addressed to increase the reliability of systematic reviews by assessing the inclusion of all relevant material.

Despite the drawbacks and potential pitfalls of electronic databases, the output is largely determined by the search strategy put in. A search strategy must be sufficiently sensitive so as to pick up all potentially valid papers but equally selective to limit the search to literature which is likely to be relevant. By carefully preparing the search strategy, the **recall** of the search and its **precision** can be optimised (CRD, January 1996). This will involve skilled adaptation of the search strategy and increasing one's knowledge of the relevant indexing terms by manuals and other relevant papers to determine the commonly used keywords (Lowe & Barnett, 1994). Suggested generic search strategies have been published as a starting point for many reviewers to uncover RCTs, articles about diagnosis, cause of disease and treatment.

Additional searches: In addition to the searching of electronic databases, experts in the field can be contacted to highlight any work which is ongoing or that they know of and feel would be appropriate. The success of this process is clearly subject to the willingness of the experts and may yield much or little information. It may be possible to include interim results of studies still ongoing, provided permission is obtained to report unpublished data.

Following the retrieval of full-text papers, the references of possible studies can be scanned to uncover any further studies which have so far slipped through the net. Handsearching may be a time consuming process but one which can be very useful. By handsearching key journals in the field, articles can be retrieved which databases have failed to identify and have been overlooked by other forms of searching due to poor

indexing, or the fact that the work is yet to be cited and entered in the database. When the handsearch yields no articles, this time, effort and information is just as important as when many articles are retrieved. The Cochrane Collaboration is in the process of compiling registers of trials relating to all fields of health care research. Their primary interest is the identification of all randomised controlled trials and by recording the results of individual searches, journals do not need to be continually re-searched. Instead, reviewers can consult these registers to check for any possible missing studies. Registers for other study designs would be a great asset and a possible directive for the future.

When reviewing trials involving pharmaceutical products, it may be worthwhile contacting related companies who often hold results 'on file' but are as yet unpublished. Moves have been made within the UK, however, to make this data more easily accessible. This range of measures helps to increase the reliability of the review and the accuracy of its conclusions (Chalmers & Altman, 1995).

4. INCLUSION CRITERIA

The decision to include any study must be made according to pre-determined criteria stipulated in the protocol. When one is developing the inclusion criteria for a review, one must consider that broadening the criteria may make the comparison and synthesis of results more difficult, but narrowing the criteria may likewise create difficulties by perhaps reducing the generalisability of the results. These a priori criteria tend to include generic terms, common to all research studies, as well as items specific to the field against which each trial can be evaluated. These criteria typically determine the objective

of interest, the setting and participant groups, possible forms of treatment and key outcome measures used to meet the objective. Stipulation of the types of study design to be considered for analysis is based on the quality of the designs and their susceptibility to bias, but also the availability of reliable study designs in the literature which may vary depending on the research topic. If studies of reliable design are few and far between, other measures accounting for validity should be imposed. Pre-determined inclusion criteria aim to reduce the bias in a review but a degree of subjectivity and 'reviewer bias' can remain. This bias can be tackled by the independent assessment of each study by two or more reviewers. If disagreements arise, they can be resolved by discussion and any concerns about the effect this decision will have on the overall results can be assessed using sensitivity analyses. To further eradicate the possibility of bias, some reviews now require all identifiable information e.g. authors' names, journal title, institution, results and conclusions to be removed to ensure reliable, **blind** assessment of each study. Caution must be observed when considering publications by the same authors but concerning the same data set. Researchers' desire to have as many publications to their name as possible can result in the same data essentially being published in two or more papers and reviewers should be aware of this with a method for dealing with it reported in the protocol.

5. QUALITY ASSESSMENT

Using the inclusion criteria, reviewers should grade the quality and validity of each study as a measure of the reliability of the findings. The design of individual studies primarily determines the degree to which the studies are susceptible to bias and consequently the

reliability of their results (CRD, January 1996). On the basis of study design, one can determine the likelihood of the observed effects being due to the intervention or confounding factors. A hypothetical hierarchy of study designs would place an RCT, the gold standard of study design, at the top of the hierarchy and a retrospective case study nearer the bottom.

An RCT controls for as many potential confounding factors as possible in order that the observed effects can be said to be due to the intervention. Random allocation of subjects to treatment groups is one important method imposed in an RCT and optimised when blind to both the experimenter and the subject. Characteristics and values, which are pertinent to the study, should be equal for all subjects at baseline to rule out any differences which may affect the results. Assessment of outcomes should be masked and the purpose of the study should be unknown to the person carrying out these tasks. Interventions lead to a follow-up period and one must ensure that time scales are set when recordings are taken for each subject. Often subjects drop out of studies. To tackle this issue and to complete the data set, researchers should employ the 'intention to treat' principle which accounts for this possibility. All statistical analyses should be justified and performed appropriately to make sure that the reliability of the RCT is upheld. These elements of the methodology reveal the rigidity of the RCT design.

In terms of their allocation of treatment to subjects, experimental designs, which include RCTs, have different mechanisms for the allocation of treatments which vary in terms of reliability. The most reliable method is clearly a random method such as randomly

generated numbers whereas pseudo-random methods of allocation such as birth date or case note number mean that the experimenter could be aware of the potential subject allocation at entry to the study. This potential flaw is less problematic than that incurred in observational studies where allocation is haphazard and it is difficult to conclude that the effects observed are due to the intervention and not simply due to chance or the effect of other factors.

Controlled before-and-after studies (CBAs) take measures from the same subjects pre and post intervention. When an RCT is not possible, this study design can perform the same task by revealing the effectiveness of an intervention. The validity of observational studies can be threatened by the non-random allocation of subjects to treatment groups and the potential for 'observer bias' and social desirability bias when someone is present. However, the degree of threat can be minimised by restricting participant selection and matching subjects on potential confounding factors but also by standardising the scores when performing analysis of the data or by use of regression models.

Systematic reviews of diagnostic tests and economic evaluations face complicated issues. The predictions of any diagnostic test are compared with the gold standard but the disease spectrum of the patients involved can have an effect on the results and this must be considered. Reviews of cost effectiveness, cost utility and cost benefit analyses, on the other hand, need to critically appraise the effectiveness of each study. Case control studies fall below cohort studies in the hierarchy of evidence due to their increased susceptibility to bias. Blind exposure to the intervention is difficult in this situation and

the treatment effects could be underestimated due to the overmatching of factors related to group allocation. All types of study are ideally carried out prospectively in order for measurements to be taken for all groups simultaneously rather than introducing more potentially confounding factors by including a time lapse. Data collection is also more reliable as people are aware of this requirement. The results given will be less likely to be influenced by the outcomes if recorded prospectively.

However, the execution of the study is just as important as the design employed. Although the strength of evidence decreases on the basis of study design, validity is equally decided by how well designed the study is, the way it was carried out and the subsequent data analysis performed. A well designed and executed cohort study is often more reliable and useful than a poorly designed randomised controlled trial.

6. DATA EXTRACTION

The final set of papers to be included in the review will have to undergo data extraction. This process is determined by the information needed to perform the data synthesis appropriate to the review. Developing a checklist specific to each review allows a standard assessment of each study to be made. Key elements should be included, however, such as bibliographic details, study design, methodology and population, outcome measures under investigation, the main results and the factors affecting their validity (CRD, January 1996). Ideally, the original numbers in each group will be available to calculate both absolute and relative effects.

Piloting of the extraction form helps to pinpoint any potential problem areas and optimise the information being extracted. The extraction process can incur human error as mistakes can be made when noting figures and a degree of subjectivity can be involved. Ideally, two or more reviewers independently extract the appropriate data and any disagreements arising can be addressed. As a systematic review is based on having all the facts then any data missing from studies should be followed up by contacting the authors. If manipulation of the data is required in order to retrieve original subject numbers, caution should be observed as assumptions can affect the results and sensitivity analyses can reveal their effect, if any.

7. DATA SYNTHESIS

The synthesis of the results of the studies included in the review serves three purposes:

a) To provide an estimate of the average effect of the intervention in question.
b) To investigate whether the treatment effect was similar for different studies, different settings and different populations.
c) To examine the differences in effectiveness of the intervention from different studies should they arise and the reasons for these.

Systematic reviews pool the data from the included studies in order to provide some overall conclusions. A qualitative or quantitative approach can be taken. However, one is advised that if the data are sparse, certain data are missing or the studies are too heterogeneous, a qualitative approach should be applied. A qualitative summary of the studies is vital and forms the basis of the analysis and it is from this that quantitative

analysis can be performed. Over the years, quantitative synthesis has attracted a great deal of attention, leaving qualitative synthesis in the background. Yet it should be noted that the quantitative phase of the analysis is an extension of the qualitative work where the homogeneity of the studies is established.

Qualitative synthesis focuses on analysis of the studies' findings in terms of the subjects involved in each intervention, the setting, the outcome measures recorded and the environmental or modifying factors which may have influenced the results. Formal methods for qualitative analysis need to be developed as are presently available for quantitative analysis. This may bring with it a greater sense of credibility for qualitative synthesis.

Quantitative synthesis, on the other hand, pools estimates of treatment effects for each study. Presenting the effects of the studies in graphical form allows the overall picture to be seen more clearly. The treatment effects of each study are represented with diamond symbols horizontally. The size of the symbol reflects the weight given to the study in the analysis. The more reliable and informative studies are given more weight (CRD, January 1996).

Meta-analysis is the name given to the pooling of results, weighting the studies appropriately. Two models can be applied to the data when carrying out a systematic review (CRD, January 1996). First, the **random effect model** is the more conservative option which tries to assure that studies included in the review are representative of a

random distribution of the treatment effects. Taking into account between study variation, this statistical model tries to account for other factors which may have influenced the treatment effects. Its lack of confidence in the sampling techniques is reflected by the wide confidence intervals. Second, the **fixed effect model** ignores the between study heterogeneity and treats the estimates of treatment effects as a single score at the basis of each study. The model changes according to the data being considered. When dealing with measurements, all of which use the same scale, the estimate of treatment effect can be calculated from the weighted mean of the treatment effects of individual studies. If the data does not rely on the same scale, the mean effect of each study must be converted to a standardised value. Both models offer similar findings but must be used cautiously as assumptions are made about the findings in both cases.

Professor Hans Eysenck voiced his reservations regarding the pooling of data as described above, feeling that it was strange to merge the results of studies which were carried out independently, using different subjects in different settings, investigating different outcomes. The meta-analysis is far from perfect, as cases have been known where beneficial effects have been found which were later found to be false. This is reason to be cautious and to apply a test of homogeneity to one's study. Such a test determines whether the variation between studies is likely to have arisen solely by chance or whether there are factors accounting for some of these differences which need to be explained. An insignificant result would demonstrate homogeneity. A test of **homogeneity** will ensure that the lower confidence interval of each study falls below the higher level of any trial. Heterogeneity would otherwise be evident. However, as the

precision and power of these tests is low, differences could still be present which need to be uncovered. Due to the imprecision of these tests, one must be cautious when interpreting the results (Greenhalgh, 1997).

To account for the variable validity of the studies, one must consider the inevitable biases. By synthesising results of different study designs and comparing the overall estimates, a comparison can be made. Alternatively, the studies can be cumulatively synthesised, noting any changes in the estimates of treatment effects as weaker designs are added. A meta-regression model could likewise be used to monitor any change resulting from the mixed validity and methodology of studies. In this case, strength of evidence can act as a variable. To assess the effect of validity on the overall results, sub-analyses can be applied. For example, by extracting one or two dominant studies from the results, one can examine whether the overall results are similar for smaller, less powerful studies.

Due to the emphasis placed on quantitative and statistical aspects of research, the published literature can be subject to bias. Journals and the authors who submit papers focus heavily on the significance of the findings, in both the clinical and statistical sense of the word. In comparison with studies showing significant findings there are few studies published which reveal an insignificant effect (Chalmers & Altman, 1995). As the exclusion of this research can influence the overall conclusions of a review of this type, tests have been developed by which the possibility of **publication bias** can be assessed. The **funnel plot**, as it has come to be known, indicates the effect size of each study

according to the sample size (Greenhalgh, 1997). A funnel shape tends to appear as the variability in effect sizes alters as the size of the sample decreases. If the funnel shows an incomplete shape this suggests that studies are missing and that publication bias may be affecting the results. Missing studies more often than not are small studies that show no effect. To minimise the possibility of publication bias encroaching upon the results, a comprehensive search should be carried out. Specialised registers of trials should be referred to, as all studies are entered before the results are apparent and therefore present an unbiased account of the literature and, finally, funnel plots can be performed.

The synthesis and analysis of the results marks the completion of the review itself but the most effective means of disseminating the information must be carefully considered. The Cochrane Collaboration play a role in this area as well, for the information becoming available as a result of systematic reviews needs to be suitably disseminated to the relevant parties in order for the purpose of the review to be fulfilled. The Cochrane Collaboration has several databases where reviews can be accessed and where the material is updated on a regular basis. For non-Cochrane reviews, the problem of journal space remains. Chalmers & Altman (1995) stress the importance of dissemination and encourage the development of electronic journals as a way of addressing this problem.

CHAPTER II

INTRODUCTION TO THE REVIEWS

Rationale Behind The Reviews

The increased profile of infections arising from blood-borne viruses such as human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV) since the mid-1980s has resulted in an examination of dental surgery infection control procedures. Measures such as the wearing of gloves, masks, and the autoclaving of handpieces were suggested by many authorities, including the American Dental Association, the British Dental Association and the Centers for Disease Control (Council for Dental Materials and Devices, 1978; Centers for Disease Control, 1986; BDA Dental Health and Science Committee Workshop, 1986). Since that time, the recommendations have been reviewed regularly, with additional recommendations being made such as the changing of gloves and the autoclaving of handpieces between each patient (American Dental Association Council on Dental Materials, 1992; British Dental Association, 1996). However, compliance with such guidelines by general dental practitioners (GDPs) has never been universal (Burke *et al.*, 1991; Verussio *et al.*, 1989), for several possible reasons. These include:

- failure of the authorities to fully explain or justify the rationale behind the guidelines
- difficulties experienced by some general dental practitioners in adapting to glove wearing
- more recently, the rising incidence of skin problems considered to be due to glove wearing (Burke *et al.*, 1995)

- complacency because there are few published reports of infections transmitted at the dental surgery, though this may reflect difficulties in identifying such infections rather than a low incidence *per se*
- the cost of implementing infection control procedures, which has been considered a factor in failure to comply with recommendations (Hogan & Brown, 1990).

A hindrance to compliance is the financial cost of infection control which has been considered high (Hogan & Brown, 1990; Burke & Sarll, 1992). This is one of the factors which may have resulted in an increase in dental treatment fees. In the United Kingdom, these costs are primarily borne by individual general dental practitioners from payments for NHS dental treatments, so they are ultimately paid from the overall NHS budget. American dental practices have likewise seen changes in dental treatment fees since the introduction of infection control recommendations by the Occupational Safety and Health Administration (OSHA). A questionnaire-based survey carried out by Feldman & Bramson (1994) in collaboration with the American Dental Association investigated the possible link between the implementation of these guidelines and the increase in dental treatment fees. The results suggest that increased costs are a direct result of compliance with OSHA's regulations. Given the evident financial cost of infection control, development and implementation of guidelines for infection control must be justified in terms of their effectiveness.

Infection control procedures in dentistry principally protect the patient from micro-organisms present on the dentist's hands and on instruments or equipment used on

previous patients. A secondary function of some infection control procedures, such as glove wearing, is the protection of the operator from micro-organisms which may be present in the patient's mouth. In this respect, a number of guidelines to dental health care workers (DHCWs) on infection control have been issued, most by dental representative associations or government bodies. However, there is little information describing the development of these guidelines or evidence that the uptake of the guidelines has subsequently been assessed by their publishers. It is also unclear what implementation strategies have been employed, other than direct mailing of questionnaires to members of representative organisations. It seems unlikely that passive dissemination of guidelines alone will be sufficient to improve the quality of care. The present research aims to identify the dissemination methods which have been employed within this field as well as gaining an understanding of areas in which DHCWs' adherence to guidelines are deficient and, consequently, lead to future research.

The research presented comprises two systematic reviews. The first review was funded by the NHS Research & Development Programme while the second was carried out under the auspices of the Cochrane Collaboration. The reviews deal with literature of differing quality but the underlying subject matter is the same for both. The purpose of the NHS R&D review was to determine the knowledge and attitudes of DHCWs towards infection control procedures, their practising behaviour in respect of infection control and whether a relationship exists between knowledge, attitudes and behaviour (e.g. adherence to guidelines). The Cochrane project focused its attention on the interventions which have

been carried out to promote adherence to dental infection control guidelines and assessed their value as this issue had not previously been addressed.

NHS R&D REVIEW: A systematic review of the knowledge, attitudes and behaviour of the dental team and their adherence to infection control guidelines.

Abstract

Objectives

To determine the knowledge and attitudes of DHCWs towards infection control procedures.

To determine the DHCWs practising behaviour in respect of infection control.

To determine whether a relationship exists between knowledge, attitudes and behaviour (e.g. adherence to guidelines).

Search Strategy

A range of electronic databases were searched using a search strategy which was developed to maximise sensitivity and specificity. Experts were contacted, reference lists scanned and the personal library of Professor FJT Burke was consulted.

Selection criteria

The quality of studies was assessed in line with pre-specified criteria relating to study design, allocation and assessment. Criteria specific to this research field were also included, for example, dental team members as participants, guidelines being assessed should be stated or referenced and outcome measures should fall within the categories of knowledge, attitudes, or practising behaviour.

Data collection and analysis

Following extraction and consideration of the data available, it was evident that due to the heterogeneity of study design, targeted participants, sample size and variety of outcome measures, any quantitative analysis would be worthless. Qualitative synthesis of the data followed.

Main Results

71 studies were identified from the extensive search and found to meet the pre-specified criteria. Data relating to numerous measures of infection control were pooled and indicated a less than adequate rate of compliance by the dental team. However, the dominance of self-report questionnaire surveys in this field introduced bias which should be kept in mind when interpreting the results.

Conclusions

The studies reviewed suggest an inadequate rate of compliance with guidelines within the dental profession. Key problem areas were highlighted as a result, but the poor design of the majority of studies compromised them. There is therefore an indication for more rigorously designed studies, perhaps incorporating a greater observational element, in order to accurately assess dental team members' adherence to guidelines.

COCHRANE REVIEW: A systematic review of the effectiveness of interventions to promote compliance with dental infection control guidelines.

Abstract

Objective

To determine the effectiveness of interventions to promote the use of infection control procedures.

Search Strategy

A range of electronic databases were searched from 1980 to present, experts were contacted, reference lists scanned, key journals handsearched and the personal library of Professor FJT Burke was consulted.

Selection criteria

Randomised controlled trials (RCTs), clinical controlled trials (CCTs), controlled before-and-after studies (CBAs) and interrupted time series studies (ITSs) involving dentists, dental surgery assistants (DSAs), hygienists, therapists, dental students, dental laboratory workers (i.e. the broad group known as Dental Health Care Workers) were considered. Studies which assessed the efficacy of interventions to promote infection control, using outcome measures such as glove, mask, and protective eyewear use, sterilisation procedures, hepatitis B vaccination, disinfection, staff training and proxy measures of knowledge, attitudes and behaviour with regard to infection control were considered for

inclusion. Potentially relevant studies were required to state the guideline being assessed or the standard practice identifiable as consistent with universal guidelines.

Data collection and analysis

The quality of studies was assessed in line with pre-specified Cochrane criteria relating to study design, allocation and assessment. Criteria specific to this research field were also included, for example, guidelines being assessed were required to be stated or referenced, or a standard practice recognisable as being consistent with universal guidelines had to be described. Outcome measures fell into the categories of knowledge, attitudes, or practising behaviour. Both observed and self-report measures were considered.

Main Results

Only one potentially relevant trial was identified, yet it failed to meet all of the pre-specified Cochrane criteria. It failed to assess key outcome measures. Furthermore, its subjective measurement of outcomes was noted and resulting biases were taken into account when interpreting the findings of this trial.

Conclusions

Only one controlled intervention was uncovered by the extensive and thorough searches. However, it failed to assess key outcome measures stipulated in the inclusion criteria. Furthermore, its subjective measurement of the outcome variables was typical of studies in this field and compromised the study tremendously. This calls for more rigorously

designed studies, perhaps incorporating a greater observational element, to accurately assess dental team members' adherence to guidelines.

CHAPTER III

METHODS OF THE REVIEWS

Materials and Methods

In this chapter, the methodology employed for both reviews is presented. The reviews differ in terms of certain inclusion criteria but the overall methodology applied is the same for both. The techniques for each review are discussed in full to provide a comprehensive account of each. The expert panel consulted and the database search strategy appearing in the NHS R&D Review also applies to the Cochrane Review.

The Review Team: Beth L. Gordon, Research Assistant; F.J.T. Burke, Professor of Adult Dental Care; J. Bagg, Professor of Oral Microbiology.

NHS R&D Review

Criteria for considering studies for this review

Types of Studies

The following types of studies were included: randomised controlled trials (RCTs), clinical controlled trials, controlled before-and-after studies (CBAs), interrupted time series studies (ITSs), observational studies, surveys and reports of infection control procedure uptake.

Types of Participants

The following groups were included in the review: dentists, dental surgery assistants (DSAs), dental hygienists, dental therapists, dental students, dental laboratory workers i.e. the broad group known as Dental Health Care Workers (DHCWs).

Types of Interventions

This was based on the criteria, guidelines and standards produced by both the NHS Centre for Reviews and Dissemination at the University of York and The Cochrane Collaboration, in particular the Cochrane Effective Practice and Organisation of Care Review Group (EPOC).

The definition of guidelines proposed by Field and Lohr (1990) was used, i.e. that "Clinical guidelines are systematically developed statements to assist practitioner decisions about appropriate health care for specific clinical circumstances". This definition is consistent with that used for a review of guidelines in professions allied to medicine (Thomson *et al.*, 1999). Examples of synonyms for clinical guidelines are: protocol (excluding study protocols) and standard.

Studies which described a standard of practice which, in the reviewers' judgment, implicitly met the definition of an infection control guideline were included. Studies were included which evaluated an entire or identified component of a guideline aimed at DHCWs. Studies were also considered where the guideline had been developed by another professional group but where the impact upon the practice or behaviour of the DHCWs had been assessed. Studies were required to state which parts of the guideline were to be implemented by DHCWs.

Studies assessing the knowledge of dental health care workers of infection control guidelines, the adherence of DHCWs to these guidelines and the attitudes to infection

control and behaviour of DHCWs were included regardless of whether the guidelines were based on evidence.

Types of Outcome Measures

The following outcome measures were included: glove use, mask use, use of protective eyewear and the changing of these items between patients; the wearing of protective clothing; the sterilisation of instruments and handpieces between patients; the disinfection of surfaces; hepatitis B vaccination of clinical staff; use of disposable items and waste disposal; training of all staff in the principles of infection control; knowledge of the dental team regarding blood borne infections; willingness, primarily of dentists, to treat HIV positive patients; infection control policy in place, an accident book for the recording of occupational injuries in place and post-exposure protocol for each practice.

Both observed and self-report measures of these outcomes were considered. However, self-report, as a measure of guideline adherence, has been found to produce a considerable over-estimation of adherence according to a review of the literature by Adams *et al.* (1999). These studies were considered separately to determine if the method of response had a significant effect on the information given.

Search strategy for identification of studies

A range of methods were used to identify reports of relevant primary research with no language limitations. These included:

i. The searching of electronic databases such as Medline, Embase, BIDS SCI and SSCI and the British Dental Association library.

ii. Scanning references cited in included articles to identify other studies from 1980-1999.

iii. Journals, from 1980 to 1999, known to publish material in the subject area were hand searched. Three were selected, namely the *International Dental Journal*, *Community Dentistry & Oral Epidemiology* and the *Journal of the American Dental Association.*

iv. The Cochrane Library.

v. NEED (NHS Economic Evaluations Database).

vi. SIGLE - a database covering grey literature within Europe.

vii. Reviewing abstracts from professional meetings and conferences.

viii. Sensitive search strategies were also developed from key words and abstracts of papers identified through the review team's previous work.

Contribution of an expert panel:

Correspondence took place with key researchers in the field. The following were contacted with a request for help:

Professor James Cottone, Professor of Infectious Disease Control in Dentistry, Texas, USA

Dr William Coulter, Lecturer in Oral Microbiology, Belfast, Northern Ireland, UK

Dr C. W. Ian Douglas, Reader in Oral Microbiology, Sheffield, UK

Professor Jeremy Hardie, Professor of Oral Microbiology, London, UK

Dr. John MacDonald, Research Assistant, Department of Epidemiology and Biostatistics, Ontario, CANADA

Professor Gillian McCarthy, Associate Professor of Department of Epidemiology and Biostatistics, Ontario, CANADA

Professor Philip Marsh, Professor of Oral Microbiology, Leeds, UK

Dr Michael Martin, Senior Lecturer / Honorary Consultant in Oral Microbiology, Liverpool, UK

Professor Chris H Miller, Professor of Oral Microbiology, Indiana, USA

Dr Graham Ogden, Senior Lecturer in Oral Surgery, Dundee, UK

Professor Chuck Palenik, Professor of Oral Microbiology, Indiana, USA

Dr Caroline Pankhurst, Lecturer in Oral Medicine and Oral Microbiology, London, UK

Professor Stephen Porter, Professor of Oral Medicine, London, UK

Professor Lakshman Samaranayake, Professor of Oral Microbiology, HONG KONG

Professor Crispian M Scully, Professor of Oral Medicine and Special Needs Dentistry, London, UK

Professor William Wade, Professor of Oral Microbiology, London, UK

MEDLINE search strategy:

1 BEHAVIORAL-SCIENCES#

2 SOCIAL-SCIENCES#

3 PSYCHOLOGY-EDUCATIONAL#

4 PSYCHOLOGY-INDUSTRIAL#

5 PSYCHOLOGY-SOCIAL#

6 BEHAVIOR#

7 EMOTIONS#

8 MENTAL-COMPETENCY.DE.

9 MOTIVATION#

10 PERSONALITY#

11 PROFESSIONAL-COMPETENCE#

12 ADAPTATION-PSYCHOLOGICAL#

13 SOCIOLOGY#

14 COMMUNICATION-DISORDERS#

15 AFFECTIVE-SYMPTOMS#

16 COGNITION-DISORDERS#

17 MENTAL-PROCESSES#

18 STRESS-PSYCHOLOGICAL.DE.

19 MENTAL-HEALTH.DE.

20 ATTITUDE#

21 HEALTH-PLANNING#

22 DELIVERY-OF-HEALTH-CARE#

23 DENTISTS-PRACTICE-PATTERNS.DE.

24 HEALTH-CARE-COSTS#

25 HEALTH-CARE-REFORM.DE.

26 HEALTH-EXPENDITURES#

27 HEALTH-PRIORITIES.DE.

28 HEALTH-RESOURCES.DE.

29 HEALTH-SERVICES-ACCESSIBILITY#

30 HEALTH-SERVICES-NEEDS-AND-DEMAND#

31 UNCOMPENSATED-CARE.DE.

32 DENTISTS# AND PX

33 BEHAVIOR OR BEHAVIOUR OR ATTITUDE$ OR OPINION$ OR KNOWS

34 MOTIVAT$ OR COERC$ OR BELIEF$ OR BELIEVE OR PSYCHOLOG$

35 COMPLY OR COMPLIANCE OR ADHERENCE OR ADHERE

36 GUIDELINE-ADHERENCE.DE.

37 COMPETEN$

38 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10

39 QUALITY-OF-HEALTH-CARE#

40 39 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20

41 21 OR 22 OR 23 OR 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30

42 31 OR 32 OR 33 OR 34 OR 35 OR 36 OR 37

43 38 OR 40 OR 41 OR 42

83 HEALTH-EDUCATION-DENTAL.DE.

84 HEALTH-EDUCATION#

85 HEALTH-PROMOTION.DE.

86 83 OR 84 OR 85

87 43 OR 86

135 PSYCHOLOGICAL-PHENOMENA-AND-PROCESSES#

136 PERCEIVE OR PERCEPTION$

137 PUBLIC-OPINION.DE.

138 PUBLIC-RELATIONS#

139 SEX-FACTORS.DE.

140 135 OR 136 OR 137 OR 138 OR 139

141 140 OR 87

44 BACTERIAL-INFECTIONS-AND-MYCOSES#

45 VIRUS-DISEASES#

46 DISEASE-TRANSMISSION#

47 CROSS ADJ INFECTION

48 NOSOCOMIAL ADJ (DISEASE$ OR INFECTION$)

58 44 OR 45 OR 46 OR 47 OR 48

59 58 OR INFECT$

49 DISEASE-TRANSMISSION# AND PC

50 INFECTION-CONTROL-DENTAL.DE.

51 COMMUNICABLE-DISEASE-CONTROL#

60 49 OR 50 OR 51

52 IMMUNIZATION#

53 DECONTAMINATION.DE.

54 PROTECTIVE-DEVICES#

55 AUTOCLAV$ OR GLOVE$ OR MASK OR MASKS OR GOGGLES OR SPECTACLES

56 WASH OR WASHING OR HANDWASHING OR VACCIN$ OR IMMUNISATION

57 STERILIS$ OR STERILIZ$

61 52 OR 53 OR 54 OR 55 OR 56 OR 57

62 61 OR INTERVENTION$

63 59 AND (60 OR 62)

64 60 OR 63

65 DENTAL-AUXILIARIES#

66 DENTAL-STAFF#

67 DENTISTS#

68 STUDENTS-DENTAL.DE.

69 DENTAL-FACILITIES#

70 GENERAL-PRACTICE-DENTAL.DE.

71 DENTISTRY#

72 ORAL-SURGICAL-PROCEDURES#

73 SPECIALTIES-DENTAL#

74 STATE-DENTISTRY.DE.

75 DENTAL-HEALTH-SERVICES#

76 DENTAL-SERVICE-HOSPITAL.DE.

77 DENTAL ADJ THERAPIST$ OR DENTAL ADJ NURSE$ OR DENTAL ADJ SURGEON$

78 DENTAL ADJ TEAM$

79 DENTAL ADJ HEALTH ADJ CARE

80 DENTAL ADJ HYGIENIST$ OR DENTAL ADJ AUXILIAR$

81 65 OR 66 OR 67 OR 68 OR 69 OR 70 OR 71 OR 72 OR 73 OR 74 OR 75

82 81 OR 76 OR 77 OR 78 OR 79 OR 80

88 HEALTH-PLANNING-GUIDELINES.DE.

89 GUIDELINES#

90 GUIDELINE$

91 88 OR 89 OR 90

126 GUIDELINE.PT. OR PRACTICE-GUIDELINE.PT.

127 91 OR 126

92 RANDOMIZED-CONTROLLED-TRIAL.PT.

93 CONTROLLED-CLINICAL-TRIAL.PT.

94 CLINICAL-TRIAL.PT.

95 META-ANALYSIS.PT.

96 EPIDEMIOLOGIC-METHODS#

97 EVALUATION-STUDIES#

98 REVIEW-LITERATURE#

99 CRITICAL-PATHWAYS.DE.

100 TIME ADJ SERIES

101 META ADJ ANALYSIS

102 METAANALYSIS

103 PRE ADJ TEST OR PRETEST

104 POST ADJ TEST OR POSTTEST

105 EVALUAT$

106 TRIAL$ OR RANDOM$ OR PLACEBO$ OR CONTROL$

107 92 OR 93 OR 94 OR 95 OR 96 OR 97 OR 98 OR 99 OR 100 OR 101

112 107 OR 102 OR 103 OR 104 OR 105 OR 106

142 MEDM 0 64 AND 82 AND 127 AND 141

145 MEDM 3 64 AND 82 AND 141

146 MEDM 3 145 AND 112

147 MEDM 0 36 AND 64 AND 82

148 MEDM 3 142 OR 146 OR 147

****

Methods of the Review

Inclusion of studies: Two reviewers (Beth Gordon and Professor F.J.T. Burke or Professor J. Bagg) independently selected the studies to be included. Disagreements were resolved by discussion with all members of the review team.

Quality assessment: Two reviewers (BG and FJTB or JB) independently assessed the quality of the eligible studies using a checklist based on the NHS Centre for Reviews and Dissemination standard checklist and the predetermined criteria specific to this review (see Appendix I). Any discrepancies were resolved by discussion.

Data extraction: Data extraction was performed by one reviewer (BG) with confirmation being provided by a second reviewer (FJTB or JB), using an appropriate data extraction form.

Data analysis: Primary analysis of the possible studies was limited to qualitative synthesis, rather than quantitative analysis. Preliminary screening of eligible studies revealed considerable heterogeneity in terms of participants, sample size, response rates and outcome measures. This would make any quantitative data analysis worthless. A variety of statistical methods had been employed by the authors of included studies. Odds ratio (OR) results will be referred to in their abbreviated form with appropriate confidence intervals (CI). Confidence intervals appearing in this review are of the standard 95% value unless otherwise stated.

Cochrane Review

Criteria for considering studies for this review

Type of studies

The following types of studies were included: randomised controlled trials (RCTs), controlled clinical trials (CCTs), controlled before-and-after studies (CBAs) and interrupted time series studies (ITSs).

Types of Participants

The following groups were included in this review: dentists, dental surgery assistants, dental hygienists, dental therapists, dental students, dental laboratory workers ie. the broad group known as Dental Health Care Workers (DHCWs).

Types of Intervention

The definition of guidelines proposed by Field and Lohr (1990) was used i.e. that 'Clinical guidelines are systematically developed statements to assist practitioner decisions about appropriate health care for specific clinical circumstances'. This definition is consistent with that used for a review of guidelines in professions allied to medicine (Thomas *et al.*, 1998). Examples of synonyms for clinical guidelines are: protocol (excluding study protocols) and standard.

Studies which described a standard of practice which, in the reviewers' judgement, implicitly met the definition of an infection control guideline were included. Studies were included which evaluated an entire or identified component of a guideline aimed at

DHCWs. Studies were also considered where the guideline had been developed by another professional group but where the impact upon the practice or behaviour of the DHCWs had been assessed. Studies were required to state which parts of the guideline were to be implemented by DHCWs.

Guidelines and dissemination strategies were classified according to the taxonomy of interventions developed by the Cochrane Effective Practice and Organisation of Care Group. Studies evaluating various dissemination and implementation strategies, including postgraduate training courses, conferences, dental assistant training courses, media campaigns, feedback from questionnaires and material sent out to GDPs by their respective dental association(s) were considered.

Types of Outcome Measures

The following outcome measures were included: glove use, mask use, use of protective eyewear and the changing of these items between patients; the wearing of protective clothing; the sterilisation of instruments and handpieces between patients; the disinfection of surfaces; hepatitis B vaccination of clinical staff; use of disposable items and waste disposal; training of all staff in the principles of infection control; knowledge of the dental team regarding blood borne infections; willingness, primarily, of dentists, to treat HIV positive patients; an infection control policy in place, an accident book for the recording of occupational injuries in place and post-exposure protocol for each practice.

Both observed and self-report measures of these outcomes were considered. However, self-report, as a measure of guideline adherence, has been found to produce a considerable over-estimation of adherence according to a review of the literature by Adams *et al.* (1999). These studies were considered separately to determine if the method of response had a significant effect on the information given.

Methods of the Review

Inclusion of studies: Following screening of the 'hits' produced by various database searches, hard copies of potentially valid studies were retrieved. Two reviewers (BG and FJTB or JB) independently selected the studies to be included. Disagreements were resolved by discussion with all members of the review team.

Quality assessment: Two reviewers (BG and FJTB or JB) independently assessed the quality of the eligible studies using the EPOC checklist (see Appendix II) and the predetermined criteria specific to this review. Any discrepancies were resolved by discussion.

Data extraction: Data extraction was performed by one reviewer (BG) with confirmation being provided by a second reviewer (FJTB or JB), using an appropriate data extraction form developed by EPOC.

Data analysis: Preliminary screening of eligible studies revealed considerable heterogeneity in terms of participants, sample size and outcome measures which would make quantitative analysis difficult. Therefore, primary analysis of the included studies was limited to descriptive, qualitative synthesis.

CHAPTER IV

FINDINGS OF THE REVIEWS

NHS R&D Review

Literature search

Database searches produced 2,420 articles of which 1,985 were excluded on screening. After obtaining hard copies of 435 full text studies, 71 were found to meet the necessary criteria. Additional relevant studies were identified from other sources. Several studies were retrieved following the scanning of references and others were uncovered following contact with experts.

Research According to Date

Figure 1 indicates the year in which each of the included studies was published. This analysis was performed in order to place the work in its contemporary context and to evaluate the development of dental infection control research over the years. However, it is important to note that many of the studies present research which was carried out several years prior to the date of publication and was published following periods of intense media coverage.

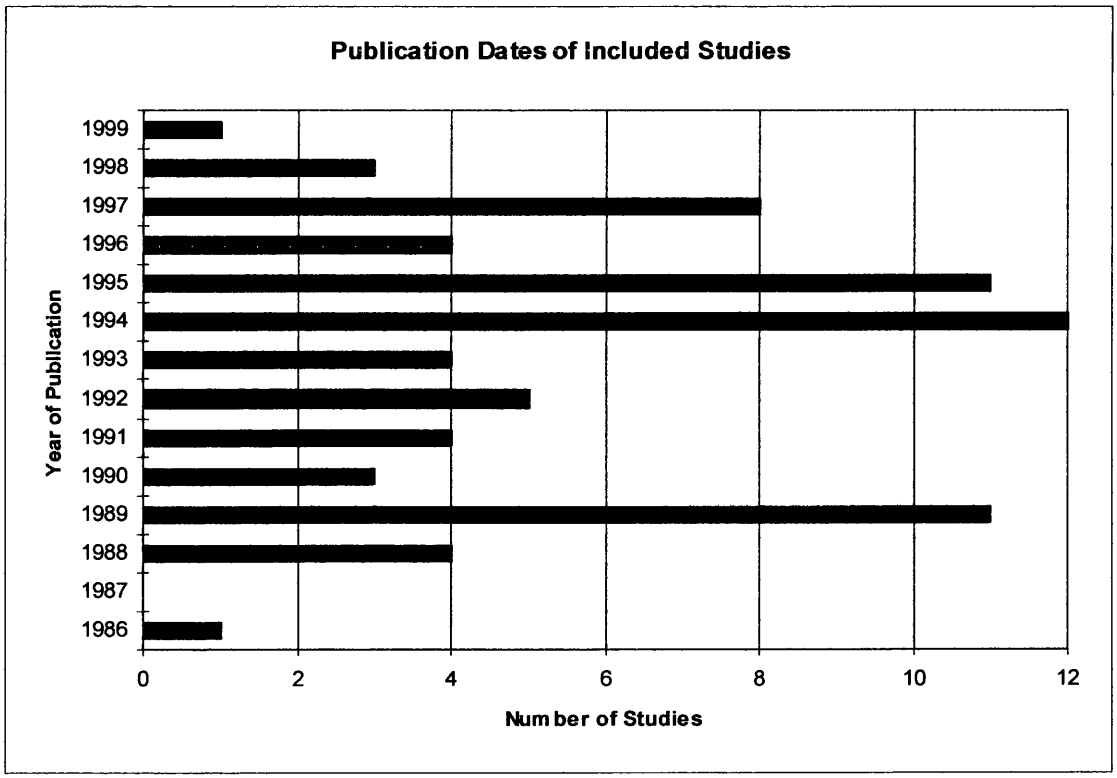

Figure 1: Graph showing the publication dates of studies included in the review.

Targeted behaviour

The targeted behaviour in all trials was the adherence to guidelines i.e. a relationship between knowledge, attitudes and actual behaviour.

Randomised Controlled Trial

The single randomised controlled trial uncovered was based in San Francisco, United States. In this trial the targeted health professionals were licensed dentists. These participants were identified by inviting all dentists licensed and practising in San Francisco to participate. They were subsequently required to sign a consent form. The trial employed a questionnaire which had been developed by Gerbert (1987) and used in previous work. For this study the questionnaire was both adapted and updated in order to collect the relevant information at baseline. To gather the necessary information, 2 knowledge scales, another scale focusing on attitudes and two further scales measuring behavioural outcomes were used. In a study by **Gerbert *et al.* (1988)**, 107 dentists from a total population of 700 agreed to participate (15%). Of those who volunteered, 91% were males with a mean age of 41.4 years. Ninety-five per cent of participants were general dental practitioners with the remainder practising in specialities. In this trial, the intervention consisted of three elements which took place during a six month period. The subjects primarily completed the questionnaire to ascertain a baseline measure of the outcome variables under investigation. The first strand involved the mailing of information bulletins. These bulletins were tailored according to the subjects' responses

on the questionnaire at pre-test. As a result, areas needing attention were highlighted. These included epidemiology, basic science, clinical science, oral manifestations of HIV infection and AIDS, as well as psychosocial and legal issues. The second component involved a feedback form detailing the individual subject's scores according to the outcome variables. Encouragement or details of possible improvements were given when warranted. The third element of the intervention involved the dentist participating in a conference call along with 5 or 6 others (within the trial) and experts from the University of California, San Francisco. Bulletins were reviewed, questions answered and discussion encouraged. The conference call lasted for approximately one hour with 36 subjects receiving the intervention and 66 subjects being assigned to the control group.

Only one comparison could be drawn from the work of Gerbert *et al.* (1988), namely, that the intervention had an effect on the dental team's adherence to infection control guidelines in comparison to no intervention. The baseline questionnaire scores for subjects in both experimental and control groups showed no significant differences ($p>0.05$). The effectiveness of the intervention in increasing questionnaire scores relating to knowledge of information about HIV and AIDS and related infection control behaviour was statistically significant in comparison with the controls who received no intervention ($p<0.05$). Significant changes occurred in favour of the experimental group for all 5 outcome variables. At baseline, scores on the questionnaire showed no substantial differences. However, at post-test, despite the fact that controls' scores had improved for 3 out of 5 outcome measures, the increase for these outcomes in the 'treatment' group was significantly greater. No indication was made as to any specific element of the

intervention provoking these changes and having a particularly influential role or whether the combination of the three components was the reason for an effect being noted.

Observational Studies

Following study evaluation, only three observational studies were found to meet the inclusion criteria for this review. They focused on varying groups of DHCWs. **Porter *et al.* (1995)** carried out an observational study within the emergency oral medicine clinic of an unidentified dental hospital in 1992/93. Seventy-nine dentists and 35 students were the observed subjects whose behaviour with patients was videotaped on 215 separate occasions. Outcome measures were determined by the universal infection control precautions defined by the Centre for Disease Control (CDC). Handwashing before and after contact, glove, mask and eye protection use were all observed and measured. For the purposes of recording and scoring the observed behaviour, a scale was developed.

Porter *et al.* (1995) offered some surprising findings. A considerable difference was observed between students washing their hands before and after patient contact and the dentists themselves. Seventy per cent of students performed this behaviour sufficiently compared to only 13% of dentists. Gloves were the most commonly used preventive measure, being worn 100% of the time by students and 81% of the time by dentists. Perhaps more concerning is the finding that masks and eyewear were not made use of as frequently as guidelines dictate to be adequate. Dental students perform more poorly than dentists on these measures. Changing of gloves between patients is considered necessary

by many authorities, but only 60% of students and 63% of dentists appeared to do so. This breakdown in guideline adherence compromises the infection control policy in a dental setting.

Ogden *et al.* (1997) performed a similar study at Dundee Dental Hospital in Scotland, UK in 1994. The study focused on the compliance of dental students with infection control guidelines. Third year (n=37), fourth year (n=36) and fifth year (n=38) dental students participated. Following completion of a questionnaire, observers measured the infection control precautions taken by the subjects before, during and after patient contact. These universal precautions outlined by the BDA (British Dental Association) Advice Sheet A12 (1991, 1996) were then further investigated by means of a self-report questionnaire which was completed by all subjects following the observational component of the study, the purpose of which remained unknown to the subjects.

The results of the study of Ogden *et al.* (1997) indicated low numbers of students who were observed not adhering to the universal measure of handwashing before donning gloves. Two per cent of third and fourth years and 5% of fifth year students failed to do so. Disinfection of the bracket table and decontamination of the 3 in 1 tip was performed in nearly all cases. Gloves were similarly worn at all times, as Porter *et al.* (1995) also found. Masks and eyewear were similarly less frequently used. The findings of the questionnaire revealed that the participants believed that all 3 PPE (Personal Protective Equipment) items were essential for conservation procedures and a necessity when extracting. In terms of protocol, the findings raise concerns. Only one out of ten students

could correctly report the protocol for blood spillage on clinical surfaces, while the protocol for the disposal of clinical waste was familiar to less than 5% of participants.

In 1990, **Scully *et al.* (1992)** described their sample as being 'randomly' drawn from an unidentified dental hospital. A range of DHCWs were involved, namely 91 dentists, 30 dental surgery assistants, 40 dental students and 22 student hygienists. These subjects were observed for 183 procedures. Observations were limited to surgical or restorative procedures only. In essence, each participant was observed only once. Several outcome measures were selected, including handwashing before and after patient contact, glove use, mask use and the cleansing of instruments post treatment. These variables were selected and measured in line with CDC guidelines (1986, 1987, 1991). Scully *et al.* (1992) observed that for 50% of dentist-patient contacts protective eyewear was not worn and on 31% of dentist-patient contacts neither gloves nor masks were worn. Examination gloves tended to be used when disinfecting surfaces while heavy duty gloves were only worn on 4 out of 44 possible occasions for instrument cleaning. For 38 out of 44 contacts examination gloves were used instead. This means that no gloves were worn for 2 patient contacts. No findings were reported for handwashing trends amongst participants.

Interview Surveys

The field of infection control in dentistry yielded a number of interview surveys which attempted to gauge the compliance of dental personnel to relevant guidelines. The research covers different dental subgroups from South Africa, Britain and New Zealand.

Naidoo (1997) surveyed a sample of qualifying dental students (n=173) from University of Western Cape Town, South Africa between 1985 and 1995. A revised and modified telephone interview was carried out and 87% (n=150) of subjects agreed to participate. Outcomes such as demographics, acceptance of the hepatitis B vaccine and general infection control practice were measured. These dependent variables were defined by the CDC guidelines (1993).

Naidoo (1997) reported that, with respect to HB vaccination, 79% of subjects had received the injection within the last five years. However, only 32% had received the booster dose and 68% had not checked their titre levels since the last dose. Furthermore, 33% were unsure of the length of immunity. Importantly, only 21% of subjects within the clinical team had been immunised. Infection control practices such as glove wearing were implemented by 92% of subjects for all procedures. Seventy-seven per cent wore masks and 40% wore eyewear. An occupationally acquired needlestick injury had been sustained during the last 12 month period by 52% of the participants. Ninety-seven per cent of injuries were followed up according to clear, post-exposure protocol. Although 85% of subjects perceived there to be a high-risk from treating HBV infected patients, 93% of respondents treated such patients.

The findings of Naidoo's (1997) survey suggest that 56 DSAs considered that information pertaining to infection control was most accessible from the dentists themselves, 54 from leaflets and 25 from dental companies. Nineteen subjects considered the availability of help and advice to be inadequate. The results suggest that time limitations determine

infection control for 74% of subjects, 14% believed facilities to be the determining factor and 6% believed lack of information was responsible.

Ashton *et al.* (1994), on the other hand, investigated a sample of dental surgery assistants working within the North West region of England in 1991. From a sample of 107, 82 agreed to answer questions (77% response rate). Infection control measures, reasons for adhering to the guidelines or not and the availability of advice regarding this issue were taken into account. A range of guidelines, including Health & Safety at Work Regulations (1992) and BDA Advice Sheet A12 (1996) formed the basis of these measures and set the scale by which behaviour was gauged.

This survey investigated the possible sources of information for these nurses. Sixty-eight per cent of subjects received information from the dentists themselves, 66% believed that some information had come from leaflets and 30% believed that dental companies had provided necessary information. The level of support offered to the DSAs was assessed. Twenty-seven per cent believed that the help and advice given to them was of an acceptable level, 44% believed it was good and 18% believed it was very good. Dental surgery assistants are an integral part of the infection control process and they offered suggestions for a breakdown in this chain. A majority of 74% believed that the practicalities of time played the greatest role, 14% believed that the necessary facilities were lacking and 6% were lacking the necessary information.

In New Zealand, **Treasure & Treasure (1997)** carried out a survey in 1992 by means of a questionnaire, followed by an unstructured interview. Three final year students were trained in the techniques of interviewing and the key questions requiring to be asked. The sample of New Zealand dentists, which was drawn from a corporation mailing list, produced a total of 1076 practices to be contacted. A 71% response rate (n=767) was achieved. However, no specific guidelines were stated as justification for measures of clinical waste disposal or the disposal of sharps, despite the fact that these variables are standard practice.

Treasure & Treasure (1997) reported that 73% of practices made special arrangements for the disposal of clinical waste. Seventy-nine per cent placed cotton rolls in waste paper bins, whilst 80% placed sharps in special containers. On the whole, results for practices within Auckland were significantly different from practices throughout the rest of the country. Only 14% of Auckland practices disposed of sharps in household rubbish compared to 24% of practices throughout New Zealand. A significantly greater percentage of Auckland based practices (76%) used a specialist firm for the uplift of waste compared with practices in New Zealand in general (45%) ($p<0.001$).

Questionnaire with other experimental component

Two studies were uncovered which combine the measurement of a questionnaire with another experimental measure in order to gain more detailed information. **Scheutz & Langebaek (1995)** investigated infection control among the Danish dental profession

between 1986 and 1993. They sent a self-report questionnaire, whose indices had been computed and dichotomised, to a 'random' sample of Danish dentists registered with the Danish Dental Association Register, as well as an indicator strip for testing the efficiency of their autoclaves. Two hundred and forty-nine of 335 dentists responded (74%). The questions about infection control practices, knowledge of HBV and HIV infection and the treatment of infected patients were based on Fédération Dentaire Internationale (FDI) 1993 guidelines which detailed appropriate infection control measures.

Overall, infection control was found to have improved between 1986 when the study was first underway and 1993. Glove use had increased from under 1% in 1987 to 17% in 1993 with 52% believing gloves to be the most important form of protective barrier to infection. There had been an increase of only 25% in the use of gloves for extractions or oral surgery over this period. Sixty per cent of dentists surveyed perceived the risk of infection through treatment to be very small with only 2% taking the opposite stance. Willingness to treat HIV positive patients had increased from 56% to 79%. A fairly high percentage of dentists had suffered a needlestick injury within the last 12 months (60%) but only 56% of these had reported the injury. An indicator strip was sent to dentists along with the questionnaire to test the efficiency of the autoclaves in practice. As many as 94% of dentists reported that they sterilised instruments using an autoclave, but 3% failed the efficiency test. Age could not explain this result as half of those machines which had failed had been bought within the previous five years.

A particularly interesting study was carried out by **Lloyd *et al.* (1995)** whose fortunate timing allowed them to extend their primary objectives. Lloyd *et al.* (1995) carried out a survey of English dentists' methods of handpiece asepsis and the problems associated with their sterilisation. Five hundred dentists were 'randomly' selected from the BT Electronic Yellow Pages. Two hundred and sixty-seven questionnaires were returned, equalling a 53% response. Fortunately, an episode of the popular documentary series 'Panorama' was aired soon after the questionnaire had been mailed which discussed the issue of handpiece sterilisation in dentistry. Lloyd *et al.* (1995) made the most of this indirect educational intervention and ascertained whether a significant change had occurred in the use of infection control measures and, furthermore, to determine the influential factors of any change.

One third of the questionnaires were sent out after 'Panorama' had been aired and therefore findings relating to questionnaires sent out before July 21, 1993 and those after July 21 were dealt with separately. A total of 174 questionnaires were included in Group 1 and 93 in Group 2. No significant differences were found between these two groups in terms of practising data or their infection control techniques, however, a significant difference was found in terms of handpiece sterilisation. In fact, 39% of questionnaires completed before the media coverage reported sterilisation compared with 60% of questionnaires completed following the televising of this programme. This indicated an increased awareness of dentists of this problem. An increase in the number of questions from patients concerning both handpiece sterilisation and sterilisation in general had likewise encouraged the necessary behaviour by dentists to allay patients' fears.

In addition, Lloyd *et al.* (1995) reported that 14% of dentists surveyed used a dental unit with a built-in disinfection mechanism, while a further 34% flushed their handpiece water lines between patients. Dentists were asked to gauge the risk of contamination via the handpiece. The results varied considerably. The majority of respondents believed the risk was low, a further 26% believed it was high and the remaining 6% who responded considered it very high. Eighty per cent of the dentists thought that sterilisation of the handpiece would prevent transmission of infection via this route. Consequently, 91% of the sample owned autoclavable handpieces at the time of the survey, yet only 54% of them autoclaved them after each patient with the rest turning to disinfectant instead. The main reason for not autoclaving handpieces was the shortage of available handpieces, which made autoclaving impractical. The damage done to them by this method of sterilisation also acted as a barrier for many dentists and time limitations imposed due to autoclaving caused problems for others. The finding that 28% simply believed that sterilisation was not necessary is cause for concern. It was made obvious that subsidisation by the government would encourage those dentists who do not autoclave to do so.

Follow-up Studies

Infection control in dentistry has developed considerably during this decade. Many follow-up studies highlight the changes in behaviour which have occurred amongst the dental profession and across the continents. **Mitchell & Russell (1989)**, for example, employed a self-report questionnaire in 1983 to assess the opinion and actual behaviour of

Scottish dentists in the Lothian and Borders region regarding infection control. This was followed by a second questionnaire in 1988 to which 168 (71%) out of 238 responded. Mitchell & Russell (1989) found that 46% of dentists surveyed wore gloves for all procedures, 22% wore gloves for selected patients only and 3% did not wear gloves at all. In total, 86% of dentists harboured objections about gloves. These included loss of sensation, an objection voiced by 67%, cost and patient reactions. Despite these problems, similarly high numbers of dentists (84%) believed they were an effective means of preventing transmission. Three per cent believed they prevented dermatitis, 10% found that patients' anxieties had been eased by the wearing of gloves and 3% believed they were important for self protection. Only 1% believed there was no advantage to wearing gloves. For the sterilisation of instruments, 30% used hot air oven and cold sterilisation techniques, 26% used autoclaves and 25% used the hot air oven only.

A commonly cited study by **Verrusio *et al.* (1989)** compared 1986 and 1988 surveys of a 'random' sample of US dentists. Demographics, attitudes towards hepatitis B vaccination and HIV, continuing education, health histories and universal infection control precautions were measured. These outcomes were deemed to be of importance by the Council on Dental Materials and advisory notices from the Department of Labour. The sample was drawn from a file containing all the names of privately practising dentists in the US. Three mailings were carried out as the first produced a low return. 58% (n= 3312) of the 5711 sample responded. A small subset of non-respondents was telephoned in order to determine the reasons for non-response and to assess whether any significant differences were evident in terms of the characteristics of the non-respondents (Verrusio

et al., 1989). This study highlighted the dramatic rise in use of gloves by GDPs and specialist dental practitioners for all procedures, which has increased from 23% in 1986 to 76% in 1988 for GDPs and 32% in 1986 to 91% in 1988 for specialist practitioners. Use of eyewear has seen a small increase from a fairly high 71% to 82% in 1988. Masks were used by 47% compared to only 26% in 1986. The willingness of subjects to treat carriers of infectious diseases had increased with regard to AIDS, hepatitis and herpes.

DiAngelis *et al.* (1989) performed a survey of all licensed dentists within the state of Minnesota in 1986, which totalled 1623. A 59% response of the total sample (n=958) was achieved. In 1987, a follow-up survey of 45% of the original sample was carried out. This comprised 827 participants which represented 61% of those contacted. Using CDC recommendations (1986) as a basis, outcome measures such as hepatitis B vaccination, occupational injuries, infection control practices, continuing education, and opinions of DSAs and hygienists of some of these issues were measured using a pre-tested questionnaire. Two demographically comparable samples were produced from the 1986 and 1987 surveys, indicating an overall increase in compliance with infection control measures between 1986 and 1987 and acceptance of hepatitis B vaccine. Compliance tended to be more likely if subjects had fewer years in practice.

Over the period of 1986 to 1988, **Bednarsh & Connolly (1990)** performed a study using a modified, self administered questionnaire to survey a 15% 'random' sample of Massachusetts licensed dentists. After a second mailing, a total response of 60% (n=700) was recorded. Measures of infection control practices, needlestick injuries and the

treatment of infected patients were taken into consideration as set out by the CDC guidelines (1987). Bednarsh & Connolly (1990) found that the number of dentists wearing gloves routinely had significantly increased from 24% in 1986 to 81% in 1988. Mask use had also increased from 26% to 51% and protective eyewear from 79% to 82%. In 1988, 88% of participants reported sterilising their instruments using a dryclave or an autoclave compared to 80% in 1986. The number of dentists who had received the hepatitis B vaccination had risen from 42% in 1986 to 59% in 1988.

A follow-up questionnaire study was undertaken by **Hellgren (1994)** whose research focused on Southern Swedish community and private dentists between 1988 and 1991. In 1988, 66% of community dentists (n=167) and 63% (n=24) of private dentists responded to the self-report questionnaire which was mailed to them. Three years later in 1991, responses rose with 78% (n=117) of community dentists and 71% (n=141) of private dentists responding. The measurement tool incorporated certain key outcome measures including demographical questions, those pertaining to infection control practices and the perceived risk of the dental team to occupationally acquired infectious diseases. Hellgren (1994) referred to Swedish National Health Board guidelines which are thought to form the basis of the dependent variables, yet no citations were made of these.

Hellgren (1994) recorded findings for both community and private dentists at the two time points - 1988 and 1991. In 1988, a disparity was noted between the two groups of dentists, in terms of their routine wearing of gloves. Sixty-one per cent of community dentists tended to wear gloves compared to only 4% of private dentists. In 1991, the

number of routine glove wearers among the community dentists had increased to 76% with 23% indicating use of gloves only for selected procedures. For privately practising dentists the percentage had also increased to 29% on a routine basis with 61% using gloves for selected procedures. This is a dramatic increase. The reasons for adopting this behaviour were investigated and a number of possibilities came to light. Sixty-five per cent of subjects believed the media had been an influential factor in this process, 26% believed scientific papers had armed them with the information to make this change while 9% reported that a joint clinical decision had been made within the practice in 1988. Three years later the influence of the media was considered to be important by fewer people but still a substantial 46%. Five per cent had been influenced by colleagues and 17% by other factors. Perceived risk of HIV or HBV infection remained fairly constant over the three year period. In 1988, the perceived risk of infection with HIV was considered small by 77% and for HBV 76% of participants. In 1991, 78% of subjects considered the risk of HIV and HBV infection to be small.

Similarly, **Manz *et al.* (1994)** compared questionnaire-based surveys from 1988 and 1991 which focused on infection control precautions, continuing education of HIV in dentistry and attitudes of the dental team towards the treatment of HIV positive patients. Five hundred and fifty-three VA (Veteran Affairs) dentists from the 885 contacted responded to the questionnaire while 132 DSAs and hygienists from a possible 156 returned their completed questionnaires. The infection control elements under investigation were rooted in a range of CDC recommendations (1985, 1986, 1987 1989) and those from the ADA Council on Dental Material (1988). Manz *et al.* (1994) compared questionnaire results at

two time points for both dentist and hygienist groups. Continuing education was assessed in this study and the findings revealed that 84% of dentists and 88% of hygienists who attended one or more courses increased to 97% and 98% respectively in 1991.

Foley (1994) made a comparison of two questionnaire-based surveys - one in 1988 and the other in 1993. The study focused on the directors of dental hygiene programmes in the US and Puerto Rico. In 1993, an 84% response was achieved (n=178/211). Questions were formulated according to a range of association and governing body guidelines such as OSHA (1989, 1991) and MMWR (1986, 1988, 1993) and then pretested. Questions were asked regarding clinical attire requirements, namely the wearing of gowns, laboratory coats, masks, eyewear and appropriate shoes. This investigation of dental hygiene programmes revealed that currently 46 programmes use disposable gowns. 46% of these programmes have their gowns professionally laundered. According to the results, all student wore the appropriate barrier measures i.e. gloves, masks and eyewear.

Following reference to CDC (1986) and FDI (1989) guidelines, **Burke *et al.* (1994)** studied compliance with infection control practices, in particular glove use among a 'random' sample of English and Welsh dentists. All dentists selected were working within NHS Regulations. A questionnaire was used to gather data on these outcome measures first of all in 1989 and again in 1991/92. In 1989, 1605 (80%) dentists replied from 2000 questionnaires sent out. In 1991/92, this response rate fell to 62% when only 1200 replies were received from the sample of 2000.

Burke *et al.* (1994) put together 723 matched pairs of subjects from 1989 and 1991/92 samples. Analyses revealed a significant difference in the number of dentists wearing gloves between 1989 and 1991/92 ($p<0.001$). Ten per cent wore them routinely at the first time point and 19% three years later. Fifty-nine per cent used cost as the main reason for non-compliance in 1989 which had increased to 61% in 1991/92. Those subjects who wore gloves less frequently tended to wear gloves when treating high-risk patients. Certain procedures such as oral surgery and scaling were more likely to result in glove wearing. Loss of sensation and manipulation of instruments proved to be another important factor for the non-use of gloves, yet numbers had decreased since 1989 from 71% to 66%. The number of dentists complying with glove use had increased from 52% in 1989 to 64% in 1991. The use of heavy duty gloves for the cleaning of instruments had not changed dramatically - 40% in 1989 and 38% in 1991. It is important to note that dentists were answering the question on behalf of the DSAs. Mask wearing remained fairly constant as did the number of respondents who used autoclaves for the sterilisation of instruments. Occupational injuries were also investigated. Needlestick injuries changed little but puncture wounds from instruments had decreased from 47% having suffered one in the last 12 months at time 1 to 40% at time 2.

Burke *et al.* (1994) published other aspects of the findings of this study in a further paper, focusing this time on a subset of orthodontists who were identified. However, findings were only reported for 1991/92. Of 40 orthodontists, 35% were male, 63% practised in a city or town centre and 63% had attended between 1 and 5 postgraduate courses during the previous 12 months. Only three orthodontists from the group reported wearing a mask

routinely and as many as 25% never wore a mask to protect against aerosols. This tendency for non-compliance was repeated with glove use. Although 60% of orthodontists wore gloves routinely, only 17% changed them between patients. Those dentists who did not change them tended to wash them between patients instead. A quarter of these orthodontists continued to wear gloves for selected patients or selected procedures only, a false belief which should be rectified. A poor 38% of DSAs wore gloves routinely when assisting with patient treatment but an unusually high 50% of DSAs wore heavy duty gloves for instrument cleaning, which is higher than reported in other studies. Infection control recommendations have become more and more detailed over recent years and demand a considerable amount of time which busy practices often cannot afford. Due to obvious time restrictions corners are cut and this can jeopardise the entire process. As Burke *et al.* (1994) reported here, 54% of DSAs spent between one and three minutes in the surgery between patients and a further 33% spent less than one minute carrying out the necessary clean-up procedures.

McCarthy & Koval (1996) drew a comparison between two studies investigating the changes in dentists' knowledge, attitudes and practice relating to HIV and AIDS. The surveys involved practising dentists from London, Ontario who appeared on the list of the Royal College of Dental Surgeons of Ontario. Two hundred and fifty-eight questionnaires were posted in 1992 and a 70% response rate was achieved. In 1994, 262 questionnaires were sent out and 76% were returned complete. Questions relating to attendance at postgraduate courses, demographics, knowledge and attitudes to HIV and infection control practices were developed according to CDC (1993) infection control guidelines.

The questionnaire was treated as highly confidential with a 'random' identification number differentiating each. Some telephone interviews were carried out.

An increase was noted in the attendance of dentists at courses aimed at increasing awareness of HIV and AIDS. Half of the respondents had participated in 1992 and this figure rose to 80% in 1994. This increase in knowledge may partly explain the reduced number of dentists who routinely took extra precautions when treating these high-risk patients. The use of barrier techniques was examined, showing that routine glove use remained high despite little change between 1992 and 1994. Changing gloves between patients was also high with 94% of the sample adhering to these recommendations in 1992 and 98% in 1994. Mask use increased from 88% of respondents reporting use of this item in 1992 to 95%, two years later. The rate of sterilisation of handpieces rose during this two year period, perhaps due to the widespread media coverage of this topic at that time. In 1992, 68% of dentists reported carrying out this recommendation and this figure rose to 85% in 1994.

McCarthy & Koval (1996) tried to assess the willingness of dentists to treat high-risk patients. Their results suggested that dentists' willingness had increased from 68% to 77% of respondents reportedly being prepared to treat HIV and AIDS patients. Paired data analysis of 85 dentists was performed and revealed several significant changes in dentists' knowledge, attitudes and behaviour. Significantly more dentists had attended continuing education courses in the previous two years ($p<0.001$). Significant changes were also noted in terms of the number of dentists who correctly reported the risk of HIV infection

following a needlestick injury as being less than 1% ($p<0.01$), who reported wearing masks ($p<0.01$), who sterilised their handpieces ($p<0.05$) and who thought infection control practices would be a 'financial burden'. A multiple logistic regression analysis of the 1994 data indicated three predictors of a dentist's willingness to treat high-risk patients: 1) willingness to attend a dentist who treats high-risk patients; 2) disagreement that treating high-risk patients results in an increased personal risk; 3) disagreement that patients would change dentists due to the treatment of high-risk patients in the practice.

McCarthy & MacDonald (1998) took a 'random' sample of Ontario dentists from the Royal College of Surgeons of Ontario's listings and posted questionnaires in 1994 and again in 1995. After consulting the ADA (1986), CDC (1993, 1996) and CDA (1992) guidelines for infection control, a self-report questionnaire, whose reliability was tested using test-retest procedures and kappa statistics, was composed and mailed to the participants. It included questions on a number of aspects of infection control including the barrier techniques used, acceptance of the HB vaccine, sterilisation of handpieces and the precautions taken for treating someone with HIV. In 1994, 4003 dentists responded and 987 in 1995. This produced response rates of 70% and 62% respectively.

In the comparison of responses by Ontario dentists in 1994 and then a year later in 1995, 788 participant pairs were made from the subjects in the 1994 and 1995 surveys. During this time, glove use had increased from 92% to 94%, as had mask use from 73% to 79%. These increases were found to be statistically significant. Vaccination against HBV fell significantly from 92% to 91% ($p<0.05$). Those not vaccinated were said to have acquired

immunity. The vaccination of the dental team had increased significantly from 64% to 77% ($p<0.001$) as had the sterilisation of handpieces from 83% to 93% ($p<0.001$). Extra precautions for HIV patients were not taken as readily (87% in 1994, 52% in 1995). This finding was significant ($p<0.001$). Continuing education was reported significantly more in 1995 ($p< 0.001$).

Questionnaire-based surveys

A questionnaire-based survey is the most common study design and method of measurement applied in this field. Surveys of this type have been performed in many different countries, targeting different participant groups and measuring a variety of outcomes. A considerable number of studies of this type met the pre-determined inclusion criteria of this review, the details of which are described below. These studies have been grouped in terms of targeted participants with the majority of studies focusing on dental surgeons themselves.

- **Surveys of dentists**

In 1988, a questionnaire-based study was carried out by **Ter Horst *et al.* (1989)** who studied 470 Amsterdam dentists (62% of the potential sample) to assess their compliance with infection control measures, their perceived risk and subsequent treatment of HIV positive patients, according to National Heath Council guidelines. The questionnaire had been previously tested.

Ter Horst *et al.* (1989) reported that 95% of dentists wore gloves on a routine basis, almost all of whom changed gloves between patients. The remaining 5% limited their use to only certain procedures. An encouraging 84% wore masks and 90% wore eyewear. 25% of the subjects admitted to not wearing either item routinely. Another safety measure of a specialised container for used needles was employed in 54% of practices. The study reported that 89% of dentists autoclaved their instruments but added that not all were doing so properly. Taking these results into consideration, it seems contradictory that following the calculation of a compliance score, 90% were found to have done reasonably or better. Age had a strong predictive effect of less than adequate compliance with those over 65 years of age being least likely to comply well ($F=6.23$, $df=3,280$, $p<0.001$). Ninety-five per cent of respondents had heard of guidelines and 87% believed that they were adequately informed about infection control. No relationship was uncovered between demographic variables and infection control knowledge. Thirty per cent asked for more training and a significant association was found between those who were less well informed and expressed more fear ($t=4.60$, $df=278$, $p<0.001$).

In a British setting, **Matthews (1989)** applied a similar methodology when surveying a sample of dentists drawn from the Avon Family Practitioner Committee in 1987. Two hundred replied from a possible 297 (70%). By referring to the BDA guidelines of 1987, Matthews (1989) compiled a questionnaire which aimed to assess the attitudes of dentists to the issue of AIDS and the carriers themselves and also their practising behaviour in relation to infection control precautions.

This study of Matthews (1989) concentrated primarily on the use of gloves within the dental practice. Forty-two per cent of dentists reported wearing gloves for all or most patients. Thirty-four per cent said they did so when likely to contact blood, 32% wore gloves when treating high-risk patients, 11% never wore gloves. Eighty-one per cent of dentists stated that they encountered difficulty when trying to manipulate small instruments while wearing gloves, which was a possible reason for not adhering to guidelines. Surprisingly, only 63% of dentists surveyed thought that the BDA had stipulated that gloves should be worn routinely. This lack of clarity is further demonstrated by the significant number of dentists who would provide treatment, but taking extra precautions; 59% would do so for HBV carriers and 42% when treating an HIV infected individual. Despite the fact that more dentists would take extra precautions against contracting HBV, a larger number would refer HIV carriers to a specialised centre for treatment (56% for HIV compared to 42% for HBV). Seventy-eight per cent reported sterilising instruments in an autoclave.

A second British based study was carried out by **Howard (1989)** who selected a 'random' sample of dental practices within England in 1987. Of 600 questionnaires mailed, 497 were returned, producing a response rate of 83%. Recommendations from the Department of Health and Social Security in 1986 formed the basis of the questionnaire which posed questions about glove use, sterilisation procedures and attendance at postgraduate courses. Howard (1989) demonstrated that, according to the reports of the dentists surveyed, 98% used a sterilised set of instruments for each new patient. Ninety-seven per cent of the practices used an autoclave for sterilisation. However, 78% reported not routinely

sterilising their handpieces using an autoclave with a further 5% only doing so sometimes. Only 60% wore gloves routinely and 19% sometimes. Less than 1% of practices reused needles. Forty-two per cent had attended an infection control related course within the last 18 months.

Population surveys often make use of 'random' sampling to attain a representative, yet more manageable sample. **Bray & Chapman (1990)**, for example, questioned a 'random' sample of practising Australian dentists, all of whom were members of the Australian Dental Association using a questionnaire modelled on US surveys. Attitudes to the treatment of HIV patients, knowledge of the symptoms, the perceived risk and actual infection control measures were all considered. One thousand, one hundred and thirty from a total sample of 1410 responded (80%). However, this only represents one third of all registered members of the Association.

The results of their work indicated that two thirds of subjects had treated patients known to be infected with HIV. When considering year of graduation as a possible predictor of willingness to treat, significantly more post-1980 graduates reported having treated high-risk patients compared to those who had graduated pre-1960 ($p<0.001$). Eighty-three per cent of participants were willing to treat such patients but 73% would prefer to refer them to a specialist centre. Eighty-six per cent believed a low to moderate risk exists when treating patients but as a precautionary measure 84% had been vaccinated against HBV. Sixty-five per cent reported wearing gloves on a routine basis and 68% masks. Twelve per cent reported that they sterilised their handpieces using an autoclave while 87%

disinfected them. Forty-eight per cent mistakenly believed that saliva is a route of transmission for HBV.

An investigation performed by **Razak *et al.* (1991)** surveyed Malaysian dentists by selecting a sample from the Dentist Register of Malaysia in 1987. This indicated the widespread research undertaken. Seven hundred and twenty-seven from 1217 dentists responded (61%). The CDC statement (1983) and advice from the BDA (1986) appear to have provided the basis for the pretested questionnaire whose aim was to determine the rate of acceptance of the hepatitis B vaccine, reasons for not doing so, perceived risk of infection, glove use and the rate of needlestick injuries. Results indicated that a total of 45% of subjects had been vaccinated and those who had not gave reasons for not doing so. Ten per cent had doubts as to the effectiveness of the vaccine, other reasons included cost, possible side effects and fear of contraction of blood borne viruses from plasma. Analysis was carried out of acceptors and non-acceptors to determine any significant differences in terms of characteristics of the two groups. No significant difference was found between the two groups in terms of routine glove use, (28% of vaccine acceptors and 22% of vaccine non-acceptors), nor the number of participants who never wore gloves, (9% of vaccine acceptors and 22% of vaccine non acceptors). No convincing differences were found between perceived risk of acceptors and non-acceptors (22% and 23% respectively) or needlestick injuries (57% and 56% respectively).

A number of studies by Burke and colleagues have been published in this area. **Burke *et al.* (1991)** sent a self-report questionnaire to English and Welsh NHS registered dentists in

1989. A total of 1530 questionnaires were returned (77%) and were completed properly. Following the recommendations set out by the Council on Dental Materials (1988), the BDA (1987), and MMWR (1986), glove use and associated problems and the occurrence of needlestick injuries were two of the main issues addressed. Burke *et al.* (1991) reported that 68% of responders wore gloves routinely. Those who failed to do so and instead used gloves for only selected patients reported that the principal reason for doing so was the loss of sensation when carrying out treatment. Use of masks was not as frequent with only 30% reporting routine use. Questions were posed as to the frequency of occupational injuries. Thirty-seven per cent had suffered a needlestick injury and 47% had suffered a laceration arising from a dental instrument during the last year. Fifty per cent of dentists reported having treated high-risk patients and a willingness to continue to do so. The field of infection control is constantly being updated and continuing education plays an important role. Fifty-nine per cent of subjects in this study attended up to 5 postgraduate courses in the previous year, 18% more than five courses.

Following this, another survey was published by **Burke *et al.* (1992)** who again took a sample of GDPs in England and Wales practising within NHS Regulations in 1989. A 'random' sample of 2000 were selected of which 1530 (80%) responded to the mailed questionnaire. Burke *et al.* (1992) attempted to determine GDPs' compliance with glove wearing, mask wearing and attendance at postgraduate courses as well as other aspects of infection control. These are measures set out in CDC recommendations (1986) and those by the Council on Dental Materials 1988.

From analysis of the data, a significant association was found between gender and glove use ($p<0.001$) with 65% of males wearing gloves routinely compared to 77% of females. A relationship was also identified between glove use and location of practice ($p<0.005$) as 70% of dentists working in a city or town centre and 71% working in a rural location wore gloves for all patients and procedures compared with 63% working in a suburban area. Another association was identified between glove use and the size of practice ($p<0.001$). As the size of the practice increased, the routine use of gloves increased. The lowest result came from dentists in single handed practices where 61% of respondents routinely wore gloves while 69% of dentists in a two handed practice did so and 72% in practices of more than two dentists. The wearing of masks on the other hand revealed no associated factors, with no significant relationships between mask use and location, size of practice or willingness to treat infected patients. The findings revealed that dentists who attended eleven or more continuing education courses in the last year wore gloves significantly more than those who did not ($p<0.009$). A strong relationship became apparent between glove use and the number of years since graduation. Seventy-seven per cent of recent graduates (within the last 5 years) wore gloves routinely compared with 62% of those who graduated more than ten years previously ($p<0.01$).

Burke *et al.* (1992) analysed the responses of a subset of orthodontists within this sample. 41 orthodontists were identified which was representative of a sixth of orthodontic specialists practising in England and Wales at that time. In the dental practice, more than a third of these orthodontists wore gloves routinely, another 49% wore gloves only for selected patients and procedures and 12% never wore gloves. However, compliance by

routine glove wearers was compromised due to the fact that only 6% changed their gloves between patients, thereby protecting themselves but putting that patient at risk of infection. Glove use was examined more closely, exposing the fact that orthodontists' compliance is influenced by a number of factors. The most reported reason for not wearing gloves is the loss of sensation which dentists feel as a result. The cost, comfort, dexterity and perceived risk of infection add to the likelihood of non-compliance. Dental surgery assistants are, on the whole, less likely to wear gloves in the dental surgery. Only 22% of DSAs of the orthodontists surveyed wore gloves routinely and 37% wore them for selected patients or procedures.

Operative procedures resulted in needlestick injuries being reported by 17% of orthodontists and 44% suffering a puncture wound in the past year. Responses would suggest that 20 of the orthodontists surveyed had treated patients at high-risk of AIDS or hepatitis B. Following instrument cleaning, autoclaving was carried out in 68% of orthodontic practices with 56% using cold sterilisation techniques as their form of sterilisation, or in addition to autoclaving.

Burke *et al.* (1998) examined the responses of 840 dentists working in the North-West region of England and in Northern Ireland to questions concerning their knowledge and use of autoclaves, sterilisation methods, use of other measures and their general opinions. This sample was selected 'randomly' from lists provided by Family Health Service Authorities and Local Health Boards in these parts of the United Kingdom. In addition to the questionnaire, each subject was sent three *Attest* spore test ampoules, marked A,B and

C. Ampoules A and B were to be placed in the middle tray of the autoclave for the first two cycles of each working day. Ampoule C acted as a control. An indicator strip was also placed in each autoclave. The owners of any autoclaves which failed the test were offered counselling in ways of rectifying the situation and offered a repeat test.

In total, 410 questionnaires were returned but only 401 of these came with the necessary test ampoules. This was a response rate of 68%. All respondents were clearly autoclave users, 20% having purchased the machine within the last three years, 38% between four and six years previously and 20% more than seven years previously. Seventy-nine per cent of machines which were more than one year old had been serviced in the year prior to this study. Almost all participants had attended at least one postgraduate course within the previous year. In preparation for autoclaving, instruments were cleaned, most often by scrubbing. Monitoring of the autoclave's functioning varied considerably between practices. Routine checks were carried out on 71% of the autoclaves in this sample by using a chemical strip, by checking the dials on the machine itself or by using a spore test. Only 5 dentists employed the third technique.

Six autoclaves from 401 were reported as failing the spore test and another two were operating at such a high temperature that the ampoules melted and thus were considered as hot air ovens and dropped from the study. Only one of these six autoclaves was found in a solo practice but four of the six were located in city or town centre practices. The dominance of practices in these locations should be kept in mind when interpreting these results. Four of the six autoclaves appeared to be over worked as they performed more

than the average 10.5 cycles each day, which supports the finding that in five of the six practices where autoclaves failed the test, more than the average 28 patients were treated each day. Results of the spore and strip tests corresponded in 99% of cases. When asked if dentists would benefit from a postal autoclave testing service, significantly more dentists based in Northern Ireland believed this service would be useful compared with the English dentists ($p<0.004$).

North America has been a forum for much research in this important field. Soto *et al.* (1993), Kunzel & Sadowsky (1993) and Gershon *et al.* (1998) have provided information pertaining to infection control compliance. The first example from **Soto *et al.* (1993)** employed a self-report questionnaire in order to assess infection control practices of dentists and their attitudes and knowledge with regard to AIDS. A 'random' sample of Canadian dentists, all of whom were registered with the Quebec dental professional corporate was chosen in 1989. A total of 1410 dentists were contacted but only 342 (24%) dentists replied. The questionnaire was constructed on the basis of ADA Council guidelines (1988) and those set out by the CDC (1986, 1988). Soto *et al.* (1993) reported that despite the low numbers of dentists who have actually treated HIV positive patients (9%) and high-risk patients (38%), there is a clear overestimation of risk when asked this question. Approximately half of dentists (51%) reported wearing gloves for all procedures but only 63% changed these for each new patient. Interestingly, 66% of respondents wore masks and 77% wore protective eyewear on a regular basis. Eighty-three per cent of dentists reported sterilising their instruments while 70% cleaned surfaces using disinfectant. This is a particular problem area which is often neglected. Perhaps the most

interesting findings are the associations between low knowledge scores and years in practice which produced an odds ratio of (OR = 2.3, CI= 1.22-4.23) and low knowledge scores and high-risk perception (OR = 1.8, CI= 1.06-3.21).

Kunzel & Sadowsky (1993) studied the level of perceived risk in the workplace, the actual exposure taken place, barrier measures used to prevent transmission, knowledge of the need for infection control and the sources of information in 1990. No guidelines are referred to in the paper where a 'random' sample of actively practising US dentists were drawn from an ADA master file. From 1832 subjects contacted using a questionnaire, 1351 (74%) responded.

Kunzel & Sadowsky (1993) reported that 65% had faith in barrier measures while 3% held opposing views. Thirty-one per cent of dentists believed that infected patients could not be treated safely in the dental office with a further 30% voicing no concerns. Incidents involving possible contamination were investigated. Seventy-five per cent believed that a needlestick injury received following treatment of an HIV carrier held the highest level of risk. Twenty-five per cent believed that blood splashed on the skin in the same circumstances carried the same risk. Several tenuous associations can be drawn from the data. First, the greater the opposition by staff to treating infected patients in the office, the greater the level of perceived risk. Lower perceived risk was associated with a greater ethical obligation to treat such patients. Those dentists who knowingly had treated infected patients were more likely to have lower perceived risk, while those subjects who

had received infection control related education and were prepared to use barrier measures were also more likely to have lower perceived risk.

Gershon *et al.* (1998) investigated infection control practices among a 'random' sample of dentists registered with the Maryland State Department Health Board of Dental Examiners. A total of 648 questionnaires were mailed and 392 responses received, producing a response rate of 60%. The questions themselves and the scale for assessing compliant behaviour was developed using a range of CDC guidelines (1985, 1986, 1987, 1988, 1989, 1993), OSHA guidelines from 1991 and several recommendations put in place by the American Dental Association (1985, 1988). The questionnaire had been psychometrically analysed and the internal validity of each scale evaluated using factor analysis.

This recent study reveals that 98% of the respondents believed that infection control measures protect against transmission but only 36% reported complying with twelve specified infection control measures. Despite their confidence in the protection which these measures offer, few carried these out which may explain the 28% of respondents who reported parenteral or mucocutaneous exposure to blood or saliva. Seven per cent had suffered a needlestick injury within the last six months, 3% of whom received follow-up. These statistics may offer reason for the 28% of respondents who believed that a high-risk of contamination exists. Setting aside these comments, the knowledge scores were generally high.

Throughout Europe, researchers have realised the significance of such work. By estimating the compliance with present guidelines, hopes exist that interventions or changes will be able to be made in order to improve the current situation. **Gore *et al.* (1994)** studied Scottish Lothian Region dentists in 1991 in order to assess the methods of waste disposal being used and any injuries being suffered by these DHCWs according to BDA guidelines. To recruit the subjects, Gore *et al.* (1994) referred to the Lothian Health Board and University staff lists, with 70% of potential participants responding. When comparisons were made between findings in 1981 and those in 1991, they found that routine glove wearing had increased dramatically from 7% to 78% with the number of people never wearing gloves falling dramatically from 56% to 1%. In 1991, 34% of dentists reported always wearing a mask and 18% of dentists never wore one.

The use of these items is only part of the recommendations to be fulfilled. Changing gloves between patients is required if transmission of infection is to be avoided, but two thirds of dentists failed to change gloves from one patient to the next and 80% wore the same mask for more than one patient. Hepatitis B vaccination is a recommended form of prophylaxis. The majority of dentists in this study had completed the course, but 12% remained unvaccinated. Those dentists who were protected had taken the first step in this process but only 67% had received follow-up antibody tests. Autoclaving proved to be the most widely used method of instrument sterilisation by 79% of subjects. Chemical sterilisation, boiling water and hot air oven sterilisation were also mentioned as possible techniques by a number of dentists. Injuries resulting from contaminated items, such as non sterile burs and needles, were sustained by 22% of dentists in the previous year.

Injuries from other instruments were sustained by more dentists during the same period (37%). This rate of injury is perhaps reflected in the tendency of 63% of dentists to resheath needles after use, without any protection.

A survey of Italian dentists by **Angelillo *et al.* (1994)** involved a 'random' sample of those registered with the Italian Dental and Maxillofacial Association in 1991. One thousand dentists were selected altogether, of which 73% responded. Outcome measures such as demographics, characteristics of participant practices, attitudes and knowledge surrounding HIV and the infection control practices to minimise transmission of HIV and other infectious diseases were incorporated into the pretested questionnaire following reference to CDC guidelines (1989, 1990).

The findings of Angelillo *et al.* (1994) indicate that knowledge was significantly higher for those dentists who had more contact with HIV positive patients. Sixty-eight per cent correctly thought that measures taken for preventing the transmission of HBV were sufficient for HIV. However, a more worrying statistic was the 22% of subjects who believed that HIV could be transmitted by saliva. This set of results suggests an air of confusion for many aspects of infection control. Fifty-five per cent believed that HIV patients should be cared for in specialised centres. Thirty-one per cent believed the refusal to treat such patients was understandable as was the fear of being infected, voiced by 83% of participants.

Hudson-Davies *et al.* (1995) mailed a self-report questionnaire to 1229 general dental practitioners in the North West of England. Nine hundred and seventeen (75%) of GDPs (age range 23 to 75 years, mean 37 years) responded to questions regarding their knowledge of infection control practices, means of keeping up to date with the latest guidelines and their opinions of the efficacy of the BDA guidelines presently in place. Hudson-Davies *et al.* (1995) found that younger dentists tended to know more about infection control ($p<0.05$). Information was gathered from dentists regarding many aspects of infection control, including their opinion of DSAs behaviour. Ninety-three per cent of dentists were vaccinated against HBV, with all DSAs in 68% of practices also being protected. Half or less of the nurses in 15% of practices had received the vaccine and in 8% of practices no nurses were protected. Ninety-two per cent were aware of the fact that precautions against HBV transmission are sufficient for HIV. Various means of barrier protection were studied and results showed that 75% of dentists surveyed wore gloves, 38% wore masks and 62% wore eyewear. Dentists reported that 64% of their dental surgery assistants wore gloves, 17% masks and 25% eyewear. Adherence to recommendations on instrument sterilisation was carried out by 91% of dentists, yet only 28% reported the sterilising of handpieces. Sixty-four per cent of dentists expressed a willingness to treat HBV infected patients while 49% were prepared to treat HIV carriers. In total, 47% of respondents were willing to treat carriers of either virus. Seventy per cent of participants believed that guidelines are important and the ones in place are feasible. In order to keep up to date with new recommendations or amendments of current guidelines, a significant 83% of subjects used dental journals as their primary source of information.

Knowledge scores for infection control and dentists' opinion scores of the guidelines show a positive correlation ($p<0.001$). However, no statistical details were given.

Walsh *et al.* (1995) investigated the glove use patterns of a 'random' sample of Brisbane region dentists in 1993. The Telephone Australia Brisbane Yellow Pages was used for the purposes of recruitment. Two hundred and one subjects took part from a total of 250 (80%). FDI (1993), CDC (1986, 1988) and a variety of council recommendations were considered when creating this study. Walsh *et al.* (1995) found that 85% of dentists wore gloves routinely and 14% wore them sometimes. The three dentists who never wore gloves were excluded from the analyses. A significant difference was found between the two groups (i.e. the routine glove wearers and the non-routine glove wearers) in terms of years of experience ($p<0.03$). Dentists who graduated more recently tended to report higher rates of routine glove wearing. Factors such as practice profile and location and adverse skin effects were not found to be significantly associated ($p<0.05$). Seventy-one per cent believed that movement of hands was a significant factor in the non-wearing of gloves while 64% believed sensation was affected. Questions were asked concerning occupationally acquired injuries and treatment of infectious patients. No significant association was found between these two factors ($p=1.00$).

Lange *et al.* (1996) surveyed a 'random' selection of dentists practising in the Brisbane region of Australia in 1993, using a self-report questionnaire. Selection was performed using a telephone directory. Four hundred and ninety-three dentists were registered within this area and a selection of 250 were contacted. Two hundred and ten of them replied

(80%). Twenty-five non-respondents were contacted in order to determine any significant differences between the two groups - responders and non-respondents. By referring to the FDI policy (1993), CDC guidelines (1986, 1988) and a number of national health related bodies, Lange *et al.* developed a measurement tool which looked at the use of personal protective equipment by Australian dentists.

They found that 85% (n=170) of Brisbane region dentists were wearing gloves routinely with only 3 dentists (2%) never wearing them. With regard to other items, all dentists reported to be wearing them. For the purposes of analysis, the sample was divided into five groups. Group 1 wore gloves routinely, Group 2 wore them for selected patients only, Group 3 wore them for selected procedures only, Group 4 for selected patients and procedures and Group 5 never wore them. Generally, the majority of dentists wore gloves for all patients and all procedures (85%). Fourteen per cent wore gloves occasionally and 3 dentists never wore gloves. In terms of individual groupings, in Group 1 (n=170), 91% of dentists changed gloves between patients but the remaining 9% only changed gloves after the session, when they were clearly punctured or when heavily stained. In Group 2 (n=11), 7 dentists changed gloves after each patient and two washed them between patients. Results from Group 3 (n=7) indicated 5 (71%) participants changed gloves after each patient. Ten dentists were assigned to Group 4 for data analysis. Ninety per cent discarded gloves after the first use while the other 10% changed them at the end of each session. The final group (Group 5) comprised 3 dentists, none of whom wore gloves but all of whom wore other items of protective equipment. Overall, 56% wore masks and 78% wore eyewear. Sixty per cent of dentists in Group 1 routinely wore masks and 81% wore

eyewear compared to only 8% of subjects who never wore masks and 8% who never wore eyewear. In the remaining groups, routine use of masks and gloves was reported despite the diminished use of gloves. This was particularly evident in Groups 4 and 5 in which all dentists wore masks and eyewear occasionally, if not routinely.

McCarthy and her colleagues are prominent figures in this area. Their work has tended to focus on Ontario dentists in Canada where large surveys have been completed. One of these required recruitment from Health Council list of Health Planning Regions **(McCarthy *et al.* (1996)**. From 5997 dentists listed, a 70% response rate was achieved. According to CDA recommendations (1992), a reliability tested questionnaire was developed to assess dentists' willingness to treat potentially infected patients, their opinions regarding AIDS and their knowledge of the disease. Compliance with infection control recommendations was investigated. Similar issues such as uptake of infection control measures, HB vaccine acceptance and needlestick injury rate among Ontario dentists were addressed by **McCarthy & MacDonald (1997)**. They used the list of members of the Royal College of Surgeons of Ontario to recruit their sample in 1994. Following adjustment for non-delivery, a 70% response rate was achieved from a potential sample of 5176 dentists. Items which appeared on the questionnaire were tested for reliability using a test-retest procedure and were based on a combination of CDC (1991), ADA (1996) and CDA (1992) guidelines. An idea of non-respondent characteristics was achieved by making two additional mailings to those who did not respond.

By means of multiple logistic regression analysis, McCarthy *et al.* (1996) found that age (20-29 years, OR = 2.5, CI 1.7365-3.6859, 30-39 years OR=1.3, CI 1.0001-1.7519) was significantly associated with willingness to treat infected patients as was the population of the town within which the practice was located (10,000 OR=1.6, CI 1.2288-2.0335, 10,000-49,999 OR=1.3 CI 1.0133-1.6219). In short, younger dentists (20-29 years) were more likely to be prepared to treat potential carriers as were those who practised in a less populated area (less than 10,000). General practitioners were indicated as being less likely to be willing to treat high-risk patients (OR= 0.6, CI 0.4922-0.7765).

McCarthy & MacDonald (1997) found that the majority of respondents were male, were over 40 years of age and practised in large urban areas. Ninety-two per cent of dentists were vaccinated against hepatitis B and 61% of the dental team were protected. Routine use of barrier measures was high in this sample with 92% wearing gloves, 75% wearing masks, 84% wearing glasses and 84% heat treating their handpieces. More than half of the GDPs who responded were concerned about the financial costs of implementing infection control. Multiple logistic regression analyses associated infection control behaviour with other characteristics. Use of infection control measures was more likely to be reported if the subject was female, over 40 years of age, practised in a town of larger population, had few concerns about the cost of infection control, aware of the fact that hepatitis B is more infectious than HIV and therefore aware that infection control precautions taken when treating a hepatitis B infected individual would be sufficient to protect oneself when treating an HIV carrier. At the opposite end of the spectrum, a lack of knowledge of the appropriate measures against hepatitis B and HIV, a misperception of the risk of

contracting HIV from a needlestick injury, being over the age of 39, having concerns regarding the cost of infection control and a fear of losing other patients if treating high-risk patients were all predictors of dentists using extra precautions when treating a potentially infectious patient. Many regression analyses were performed and gender was found to be a confounding factor.

McCarthy *et al.* (1999) measured the frequency of occupational exposures to blood borne diseases experienced by Canadian dentists and factors associated with this. A national survey was carried out by sending a questionnaire to a stratified 'random' sample of 6,537 dentists from the total of 15,232 listed by licensing bodies. Different provinces were weighted according to the number of dentists practising in that area in order to equate the probability of selection among the provinces. The questionnaire was developed to investigate the socio-demographics of the subjects, their treatment of HIV and HBV positive patients, occupationally acquired injuries and the follow-up procedures, as well as the attitudes and knowledge relating to HIV and AIDS. The reliability of the item appearing on the questionnaire was tested using a test-retest procedure. Non-respondents received two additional mailings in order to maximise response. Adjustment for non-delivery of questionnaires resulted in a sample size of 6,444. In total, 4,281 questionnaires were received, representing 66% of the potential sample.

The survey revealed that 67% of the sample had suffered an occupational exposure, 62% had sustained a percutaneous injury and 29% a mucous membrane exposure. In terms of prophylaxis, of the 91% of respondents who had been vaccinated against hepatitis B, only

72% had undergone the necessary post immunisation serology to determine whether they had developed a protective level of anti-hepatitis B surface antibody. Analyses of variance indicated a significant association between the number of exposures and the marital status of the subject, their speciality, an increased patient load and subsequent non-compliance with the recommended procedures. When the age variable was controlled for a significant association was found between percutaneous injury and 1) non-compliance with post-exposure protocols 2) a lack of use of puncture proof containers 3) treating more than 20 patients per day 4) being male. Accounting for age and specialty factors, splash exposures were significantly less likely to happen to dentists who failed to use eye protection or masks compared with routine users.

Axell *et al.* (1989) carried out a questionnaire-based survey of 465 Swedish dentists to ascertain their use of barrier measures, their rate of occupationally acquired injuries and their attitudes towards hepatitis B and HIV. These outcome measures are identifiable as standard infection control practices, although no specific guidelines were given. A high response rate of 87% was achieved by Axell *et al.* (1989). The responses of these dentists revealed high compliance in terms of mask and eyewear with 79% and 77% dentists making use of these respective items. Glove use was considerably lower with only 43% of respondents adhering to this recommendation. Autoclaving of instruments was reported by 90% of dentists yet handpiece sterilisation was carried out by a poor 16%. As many as 60% of respondents reported having suffered a needlestick injury during the previous twelve months.

In terms of attitudes towards infection control, the majority of subjects (66%) believed that HIV positive patients ought to be referred to a specialist clinic for dental treatment for a number of reasons. A significant number of dentists believed their practice was not suitably equipped to deal with such patients while others considered the fear of infection, the possibility of losing other patients and the potential problems with personnel sufficient enough to warrant referral. The attitudes of these Swedish dentists appeared to be linked to their contact with infectious patients. Those dentists who had treated hepatitis B infected patients were then more likely to be willing to treat an HIV positive patient. In general, the dentists felt that they had the right to know the HIV/ hepatitis B status of the patients in order to carry out the necessary treatment.

Pitts & Nuttall (1988) surveyed the community dentists and GDPs in Scotland in 1987. All those who were registered with the General Dental Service (GDS) and Community Dental Service (CDS) were contacted, totalling 1178. A 72% response rate was achieved. Protective measures such as glove use were investigated in respect of BDA guidelines (1987), as was the care of HIV positive patients and dentists' willingness to treat them. The results of this study by Pitts & Nuttall (1988) indicated that approximately one third of respondents used gloves for routine treatment. This number increased to 79% when respondents carried out invasive procedures. Mask use was considerably less than glove use with only 28% of dentists and 14% of respondent DSAs using masks. Eye protection for DSAs and patients was low and approximately half of dentists wore protective glasses but this included dentists who normally wear corrective glasses.

Questions pertaining to instrument sterilisation were put to the participants. Fifty-eight per cent of respondents used an autoclave to sterilise instruments, 44% used dry heat apparatus and the remainder relied on cold sterilisation techniques. Questions relating to vaccination against HBV made it clear that 80% had been vaccinated against HBV and the same respondents indicated that their DSA had also been vaccinated. Uptake of this vaccine differed between the two groups - respondents who were members of the GDS and those working for the CDS. GDS-linked subjects showed greater uptake of the vaccine with 30% of the CDS subjects remaining unvaccinated. Pitts & Nuttall (1988) also surveyed the willingness of dentists to treat HIV infected patients. The sample was asked how they would react to a patient telling them they had been diagnosed as HIV positive. More CDS-linked dentists were prepared to treat the patient (69%) than GDPs (52%). Subjects were given a list of eight recommendations to be taken into consideration when treating such a patient. CDS-linked dentists consistently gave greater importance to each item than GDPs, but four items including gloves, glasses, masks and treatment at the end of a session prove to be the most important precautions for both groups of subjects.

Circulation of a questionnaire relating to prophylactic measures against hepatitis B to dentists by **Matthews *et al.* (1986)**, resulted in a 61% response. All 357 dentists practising within the Avon Area Health Authority were contacted and 218 of them answered questions relating to hepatitis B vaccination, side effects, the reasons for accepting or not accepting the vaccine and the use of gloves during patient contact. No explicit guidelines were given but such outcomes are recognisable as standard practice.

This study of prophylactic measures against hepatitis B indicated that 55 subjects from this sample had been vaccinated against HBV at the time of the study while a further 15 were presently undergoing the vaccination programme. These 70 subjects only represent 32% of those who responded to the questionnaire. Of those who had received the vaccine, 12% had suffered mild side effects such as irritation at the site of vaccination and 'flu-like' symptoms. One hundred and forty-eight dentists in total remained unvaccinated. Fifty-four per cent reported their intention to be vaccinated but said they had not yet made the appropriate arrangements. Three per cent found that no one was willing to vaccinate them. The remaining dentists reported a variety of reasons for them not having been vaccinated. Twenty-two per cent refused the vaccine because of their fears of contracting HIV from a plasma derived vaccine. A further 12% were concerned that the pre-vaccination test for HBV surface antigen would prove positive and thus cut short their career. Other reasons for non-compliance with infection control recommendations included 9% who reportedly were unaware of the existence of such a vaccine, 5% who were advised by their GP not to be vaccinated and those who were afraid of subsequent allergy, side effects or objected to animal testing involved in the production of the vaccine. Only one dentist had natural immunity to HBV. Only 20 out of the 70 dentists who had been vaccinated sought a follow-up antibody titre test. In terms of barrier protection use, 8% of dentists in this sample wore gloves routinely and as many as 32% of dentists never wore gloves. Even when presented with a known high-risk patient only 60% of dentists said they would wear gloves.

Bentley & Sarll (1995) mailed a self-report questionnaire to dentists in the North-West of England in 1990 to investigate infection control and the influence, if any, of recent media coverage of the subject, in particular documenting the case of Dr. Acer. Five authorities were selected and 312 out of 422 dentists responded, producing a respectable 74% response rate. The issues examined were recognisable as standard infection control measures. According to the findings, 86% of dentists wore gloves routinely with 80% of their DSAs following suit. Other protective items, such as masks and glasses, were used by 68% of dentists and 48% of DSAs. Only 31% of DSAs reported wearing heavy duty gloves for the cleaning of instruments. Handpiece sterilisation was carried out by 77% of the dentists. Compliance with infection control and sources of information were investigated. BDA guidelines proved influential for 70% of dentists, with the media having an effect on 50% of dentists' behaviour. Dentists were asked whether inquiries regarding infection control practices had increased in the months surrounding the televising of 'Panorama'. The majority of practices reported less than ten inquiries. Asked if the programme had discouraged the public from seeking dental care, more dentists (56%) believed there had not been a detrimental effect.

Treasure & Treasure (1994) surveyed all New Zealand dentists appearing on an unspecified corporate mailing list in 1992. One thousand and seventy-six practices were identified in total and 773 useable questionnaires were returned, making a response rate of 72%. Their questionnaire focused on the current procedures being employed for cross infection control in New Zealand practices according to New Zealand Department of Health Guidelines (1988) and the dentists' perceptions of these procedures. Treasure &

Treasure (1994) attempted to assess the sources of information useful to the issue of infection control. Eighty-one per cent of dentists in their survey found that information appearing in journals was generally useful, but 11% believed it was irrelevant or unrealistic. The New Zealand Dental Association practice manual, personal professional experience, dental equipment suppliers and continuing education courses were also considered useful sources of information. Even formal guidelines were generally well received.

In this study, high-risk patients were defined as individuals with serological markers of HIV or who were HBsAg positive. Dentists were asked about the treatment of potentially infectious patients. Twenty-five per cent reported that no high-risk patients had sought treatment. A further 26% treated regular patients but would refer a high-risk individual elsewhere. Forty-one per cent of dentists said they would treat anyone. Fifty-four per cent of those dentists who were willing to treat high-risk patients tended to see the patient at the end of the day or at the end of the session.

Questions relating to sterilisation methods revealed that many practices use more than one means of sterilisation. In 92% of practices, autoclaves were available and in 15% of practices dry heat sterilisers were also available. Other methods such as pressure cookers, chemiclaves, cold sterilisation solutions, ultraviolet light, ultrasonic baths and stericabinet were mentioned by at least one practice. The majority of dentists autoclaved extraction forceps and matrix bands although 11% did admit to occasionally wiping forceps with an alcohol wipe or cold disinfectant. Only 43% of practices autoclaved handpieces and 56%

of these noted deterioration. Glove use amongst this sample was high, with 95% of dentists wearing gloves routinely. This figure was considerably lower in 1988 (43%). Some dentists thought that offering protective items to patients such as eyewear would suggest clumsiness and used this line of thinking as justification for their behaviour. The main reason for not wearing gloves, masks and glasses was the supposed inconvenience. Other possibilities such as cost, patient comfort and necessity were not as important. The main reason against autoclaving was cost. Treasure & Treasure (1994) found that awareness of the need for cross infection control had changed. Forty-eight per cent of respondents reported that the time spent with each patent had increased as a result. Sixty per cent believed that the time between patients had also increased and practice costs were greater according to 57% of dentists surveyed.

Kunzel & Sadowsky (1991) selected a 'random' stratified, computer generated sample of 1832 actively practising US dentists from the 6370 dentists which appear in the ADA master file dated 1989. After adjustment for incomplete questionnaires, 1351 responses were received, an 88% response rate. Analyses of the information were performed following stratification of the data according to the respondents' practice locale. Subjects' answers were divided into those from central cities, those from other urban areas and those from rural areas.

Data analysis revealed that the willingness of dentists to treat was not significantly different across the three different practice locales. Practice location was associated with dentists perceptions of exposure to HIV by patient contact. Those working in city centres

were more likely to think they had treated HIV positive patients ($\chi^2 = 23.324$, $p<0.001$). Sixty-nine per cent of respondents voiced concerns about acquiring HIV. In fact, 97% of dentists said they had the right to know the HIV antibody status of each patient. Rural practising dentists tended to agree they would not treat homosexuals because of the link with AIDS. Their concerns of treating infectious patients were greater for carriers of HIV compared with carriers of HBV ($\chi^2 = 7.534$, $p<0.02$). Three quarters of dentists working in all three areas agreed that other patients may leave their practice if aware of the fact that other infectious patients were also undergoing treatment.

The knowledge of dentists was studied using a number of questions. Which body fluid is most associated with HIV infection? Should all patients be considered potentially infectious? Can saliva transmit HIV? This sample of dentists showed a good knowledge, answering the first two questions correctly. The final question caused problems for a number of subjects with only 56% answering correctly. Practice location did not attract certain age groups or those dentists who attended more or less hours of continuing education courses. The only difference appearing was that solo practices tended to be located in rural locations as opposed to cities or urbanised areas.

Razak & Lind (1995) performed a questionnaire survey of professionally trained Malaysian dentists in 1990, recruiting them from a list of those who had been granted the Annual Practising Certificate to practice which appeared in the Malaysian Government Gazette in 1990. From the 1330 questionnaires posted, 972 were returned. This total was adjusted to 1330 as 41 questionnaires were returned due to retirement, change of address

or postgraduate studies overseas. This was a 73% response. Infection control procedures such as barrier techniques, disinfection and sterilisation methods and injury protocol were measures yet no specific guidelines were named as the basis of these questions.

In general, 54% routinely wore gloves but 13% routinely did not. Analyses were performed to reveal the significance of the number of years spent in practice in relation to infection control issues. The number of dentists not wearing gloves increased with their seniority of service ($p<0.01$). Ten per cent, 16% and 26% of dentists fell respectively into the categories of 0-10 years, 10-20 years and >20 years in practice. Male dentists tended not to wear gloves as routinely as women ($p<0.01$) and private practitioners were more likely to use them in comparison with public dentists ($p<0.01$). The number of males and private practitioners wearing eyewear increased with the number of years in practice ($p<0.01$). Mask use for all procedures decreased significantly with years in practice ($p<0.05$). In the office, only 7% of dentists sterilised handpieces after each patient while 82% simply disinfected them. The remaining 11% reported taking no steps to prevent contamination. Significantly more dentists sterilised their hand instruments - 78% in total. 21% used disinfectant instead. Needlestick injuries were fairly high with 31% reportedly suffering 1-3 wounds in previous months and 4% sustaining as many as 4-6 puncture wounds during this time.

- **Surveys of specialist practitioners**

Despite the fact that the majority of these studies have focused their efforts on assessing the compliance of general dental practitioners with infection control guidelines, several have pinpointed specialist groups of dentists. For example, **Woo *et al.* (1992)** surveyed Californian orthodontists and general dental practitioners in order to draw comparisons between the two groups. The orthodontists were drawn from the Pacific Coast Society of Orthodontists and the GDPs from the ADA. One hundred and twenty-four orthodontists (61%) responded while the response of GDPs was poorer with 126 (approximately 25%) replying. Recommendations from the CDC (1986, 1987) and the Councils on Dental Therapeutics (1985) and Dental Materials (1988) formed the basis of the questionnaire which enquired as to the subjects' perceived risk of HIV and HBV, barrier protection use and the sterilisation and disinfection procedures employed.

The results of this study by Woo *et al.* (1989) imply that, overall, orthodontists' behaviour in relation to infection control is not as compliant as GDPs. Analyses revealed that GDPs and their assistants wear barriers significantly more often than their orthodontist counterparts ($p<0.005$). For example, 94% of GDPs reportedly wore gloves in comparison with 80% of orthodontists. Ninety-five per cent of GDPs changed gloves between patients but only 59% of orthodontists did so. Seventy-nine per cent of GDPs wore masks compared with 17% of orthodontists. Eyewear was also worn significantly less by orthodontists ($p<0.005$). Sterilisation of handpieces, pliers and instruments is reported less by orthodontists as is the disinfection of impressions before being sent to the

laboratory. Orthodontists reported more frequent injuries than GDPs - one in every four weeks compared to one in 10 weeks. It would appear that orthodontists have a considerably different outlook to the issue of potential infection. Orthodontists perceived less patients to be carrying HBV or HIV compared to the GDPs in this study.

Cohen *et al.* (1997), on the other hand, carried out a survey of a 'random' sample of US endodontists. This sample included a number of participants who were serving abroad in the military. From a pool of 2603, 750 subjects were selected, of which 422 responded. This produced a response rate of 56%. It is important to note that although more than half of the sample responded, this is a fairly small proportion of the overall pool. Demographic information was recorded as well as acceptance of hepatitis B vaccination and endodontists' willingness to treat potentially infected patients. These parameters, like the previous study, were drawn from CDC guidelines (1984, 1987). It was reported that 95% of their 'randomly' chosen sample had been vaccinated against HBV with 82% of their entire offices following suit. Ninety-five per cent of responders reported wearing gloves for all procedures with this figure rising to 99% when those who limit the use for selected procedures were included. When asked about willingness to treat an infected individual, the participants showed little difference in their willingness to treat HBV and HIV, 95% and 93% respectively. The majority of participants were willing to treat a herpes infected individual, but slightly fewer were prepared to carry out treatment of a carrier of tuberculosis.

Dental specialists registered in British Columbia, Canada were surveyed by **Epstein *et al.* (1995)** to determine their knowledge of infectious disease and the appropriate infection control practices used to prevent transmission according to CDC (1991) guidelines. Two hundred and two pilot tested questionnaires were sent out and 137 dentists replied. Non-respondents were contacted by telephone to assess whether non respondent data were significantly different.

Epstein *et al.* (1995) reported that 71% wore and changed gloves routinely while 25% washed and reused them. Other infection control measures such as sterilisation of instruments were investigated. Ninety-two per cent disinfected or sterilised their handpieces, but only two thirds of these subjects heat-treated their handpieces. The disinfecting of impressions is a question often not asked and here 47% reported rinsing impressions before sending them to the laboratory and 5% neither rinsed nor disinfected them. Eighty-two per cent disposed of sharps in proper containers.

A postal questionnaire survey of practising Ontario orthodontists was carried out by **McCarthy *et al.* (1997)** in order to assess their compliance with infection control procedures recommended by the ADA (1996) and CDC (1993) and to compare their findings with those of GDPs in 1994. Five thousand, four hundred and forty-one questionnaires were posted to all GDPs and orthodontists practising within Ontario, resulting in a 70% response. Similar proportions of each group had reportedly been vaccinated against hepatitis B (94% and 92% respectively) and took additional precautions when treating HIV+ patients (80% and 78% respectively). For several

infection control measures significant differences were found between the orthodontist and GDP groups. For example, the vaccination of the dental team for HBV differed significantly between the two groups ($p<0.001$) as did the use of gloves ($p<0.05$), the changing of gloves between each patient ($p<0.0001$), mask use ($p<0.0001$), the wearing of protective eyewear ($p<0.0001$) and the heat sterilisation of handpieces ($p<0.0001$). In the case of each independent variable, orthodontists showed lower compliance with recommended infection control measures.

Evans (1989) studied current opinions regarding cross infection control held by orthodontists in the United Kingdom. Specialists belonging to The British Association of Orthodontists, the Consultant Orthodontists Group or the British Society for the Study of Orthodontics who worked in hospitals, in the community or as GDPs were contacted. This amounted to 285 questionnaires being sent out, of which 189 were returned by 81 specialist practitioners, 57 orthodontists working in District General Hospitals, 29 from teaching hospitals and 22 community orthodontists. The small numbers of representatives of teaching hospitals and community orthodontists has been noted. Answers were considered in line with ADA (1985) and BDA (1987) guidelines on this subject. According to responses, 62% of dentists in the sample had been vaccinated against hepatitis B and a further 30% were considering being vaccinated. However, no significant difference in the uptake of the vaccine was found between the four employment groups ($\chi^2 = 1.61$, df=3, $p>0.7$). Almost one third of dentists sampled never wore gloves (62/189) and approximately 21% wore them for all patients. A further 47% considered wearing gloves for specific patient groups. Specialist practitioners proved to be the group least

likely to wear gloves with 45% failing to do so, compared with 32% of community dentists. Although 21% of dentists reported routine glove use, further information revealed a high level of reuse as, on average, no more than three pairs of gloves were used in each session.

Sterilising instruments is equally important in an orthodontic setting yet methods of sterilisation seem to vary widely. Only 30% sterilised pliers using an autoclave. Furthermore, matrix bands, which are likely to be contaminated with blood, were sterilised more often than pliers but only in 49% of practices. Disinfectant solutions such as glutaraldehyde are also popular but sterilisation is not achieved for up to 10 hours. Only 23% autoclaved handpieces, with alcohol wipes being the preferred method for 38%. Recommendations have recently highlighted the need to disinfect impressions. The orthodontists sampled do not appear to take this precaution as 72% have never disinfected impressions. This behaviour was justified by them as they had not yet been required to treat a high-risk patient and asserted that if the situation arose they would alter their technique. Seventy-nine per cent of those who did disinfect impressions did so using glutaraldehyde solution. Caution has to be observed however as this disinfectant can cause significant dimensional changes to alginate if immersed for the recommended thirty minutes, and is highly toxic to humans.

- **Surveys of dental hygienists**

Hygienists play an important role in the maintenance of dental health among patients. Their work demands direct contact with patients and therefore a risk of transmission of infectious diseases. **Ter Horst (1993)** recognised the need for compliance with universal precautions amongst the hygienist group and chose a 'random 'sample of 378 (56%) practising Dutch hygienists and all 118 hygienists based in Amsterdam. The Dutch Health Council guidelines provided the framework for the previously tested questionnaire which looked at compliance with recommended infection control measures, the treatment of HIV patients, perceived fear and general attitudes towards and experience of HIV positive patients.

Ter Horst (1993) calculated overall compliance in his sample. 85% of hygienist subjects produced scores indicating moderate or accurate compliance and 38% had poor compliance. Eighty-one per cent believed they were adequately informed about the AIDS virus. Eighty-nine per cent stated that they gathered this information from dental literature, 78% reported using the media as their information source. However, 45% would like to have additional training on infection control. They also offered findings relating to glove use. Of those who wore gloves, 88% wore them for the entire procedure. Sixteen per cent changed them between patients, but 2% did not wear them at any time. Masks were worn more frequently, with 85% doing so. Four per cent of this group wore them all the time. Protective eyewear was worn by 75% of hygienists, 50% of these subjects wearing them all the time. As one would expect, hygienists had a higher

perceived risk of infection from patient to hygienist than *vice versa*. Less perceived knowledge was thought to associate with higher perceived risk, as analyses indicated ($F=11.64$, $df=1.256$, $p<0.01$). An arbitrary score of fear was calculated from particular answers given. Fear was found to be positively correlated with estimation of risk of HIV infection ($F=3.48$, $df=2.158$, $p<0.03$). Comparisons were drawn between hygienists from larger cities and those from rural locations. The hypotheses which were made generally were not confirmed. Amsterdam hygienists appeared to be more likely to use a mask. No differences were discovered in terms of perceived knowledge. However, Amsterdam hygienists were less fearful. ($t=4.32$, $df=191$, $p<0.01$). This links to the result that hygienists who report treating seropositive patients are five times more likely to practise in Amsterdam.

Snyder (1993) likewise took a 'random' sample of licensed dental hygienists, but whose place of practice was Pennsylvania, USA. Within the state of Pennsylvania, 4209 hygienists are in practice. Three hundred hygienists were 'randomly' selected and a questionnaire was mailed to each one in 1991. From a total of 220 replies received, only 154 were useable which produced a response rate of 64%. Using guidelines defined by CDC (1985, 1986, 1988) and OSHA (1992), Snyder (1993) measured knowledge regarding infection control recommendations, the actual infection control measures practised by this sample of hygienists and their attitudes to AIDS patients.

Snyder (1993) found that 94% of the selected sample of hygienists showed adequate or 'large' knowledge about AIDS, according to their AIDS knowledge index. Ninety-three

per cent showed 'comprehensive' knowledge of infection control procedures, according to their index. Seventy-one per cent were aware of the fact that measures against HBV are sufficient for HIV. Compliance with infection control recommendations was highlighted by the reports that 98% of hygienists wore gloves, 88% wore masks and 88% wore glasses for all patients. Seventy per cent of the sample had been inoculated against hepatitis B. Large numbers of hygienists reported disinfecting light handles (97%), bracket tables (99%) and chair switches (97%) following treatment. Analyses were done to assess the relationship between knowledge and compliance with infection control recommendations. An association was uncovered, yet no statistics were provided.

From the dental team, dentists and hygienists in particular are the members who have greatest direct contact with patients. **Waddell (1997)** studied Western Australian dentists and hygienists registered with the appropriate branches of the ADA. Sixty-three per cent of dentists (n=208) and 76% of hygienists (n=550) who were contacted responded to the mailed questionnaire. The perceived risk of treating infected patients while performing specific procedures, the opinions regarding treatment of these patients and the suggestion of mandatory HIV testing for all DHCWS were some of the issues addressed in the questionnaire. However, no specific mention was made of rates of compliance with infection control measures. Subsequently, no reference was made to guidelines except for an FDI World Health Congress held in 1990. Waddell (1997) divided the sample into low and high-risk groups for analysis. High-risk groups were less likely overall to perform invasive treatment on HIV positive patients. In line with this they were more likely to terminate treatment if oral manifestations of HIV were identified. These high-risk subjects

were more likely to be in favour of the testing of dental personnel for HIV. A significant difference was found between the perceived risk of hygienists (mean 36.5%) and dentists (mean 44.1%) ($t=4.12$, $p<0.001$).

- **Survey of dental surgery assistants**

The role of the dental surgery assistant in practice infection control is paramount. Without their compliance any adherence by other team members is rendered valueless and the entire process breaks down. As a consequence, the work of **Wood (1995)** is both interesting and potentially influential as a 'random' sample of registered hygienists and certified DSAs from Rhode Island, USA were compared. From a sample of 267 hygienists, 171 (64%) replied and from 260 DSAs, 153 (59%) replied. These samples represented 27% and 34% respectively of the total corresponding populations on Rhode Island. Following a range of guidelines such as ADA (1992), CDC (1986, 1993), OSHA (1991, 1992) recommendations, questionnaire items, whose content validity had been pilot tested, were developed pertaining to certain aspects of infection control, for example, infection control practised, participation in continuing education courses, existence of written protocols within the practice setting and the perceptions of decision making within the dental office.

The study by Wood (1995) uncovered large numbers of subjects who complied with infection control recommendations on a number of measures. Ninety-nine per cent of DSAs wore gloves, 84% wore masks, 70% wore eyewear and 21% wore face shields.

These figures were fairly similar for the hygienist group of which 99% wore gloves, 94% wore masks, 59% wore eyewear and 14% wore face shields. Written protocols were in place for occupational exposure in 78% of DSAs' practices, 74% had 'clean-up" protocols and 79% had policies for instrument sterilisation. These barrier measures are well documented in the infection control literature. However, less well recognised measures which include placing disposable barriers on light handles and flushing waterlines are often forgotten, as the case seems to be in this study, where 50% of DSAs and 46% of hygienists failed to protect light handles and 46% and 54% of DSAs and hygienists respectively flushed waterlines at the beginning of each session. Waste disposal was assessed, with 91% of DSAs and 89% of hygienists placing used needles in puncture resistant boxes. More DSAs reported using an autoclave to sterilise handpieces, compared with 67% of hygienists.

The findings of this study suggest that DSAs feel that they have a large role to play in the infection control process within the practice. Seventy-one per cent have the responsibility to sterilise instruments. Only 3% of hygienists felt the same way. To keep up to date, 74% of DSAs and 75% of hygienists had attended a continuing education course within the previous 12 months to increase their awareness and knowledge. This being said, the fact that only 57% of DSAs used heavy duty gloves to clean instruments raises concern.

- **Surveys of clinical dental staff and students**

Development of infection control policies began in the 1980s and to date many changes and alterations have been made to the preliminary recommendations. Additions have been made as research reveals the scale of the problem and as new micro-organisms are identified and have to be tackled. Infection control is now an integral part of any undergraduate dentistry degree, for the knowledge and attitudes of present graduates will dictate the climate of infection control for the future. With this in mind, **Gilbert & Nuttall (1994)** contacted the deans of all UK dental schools in order to gain access to final year students. Fifteen of the sixteen schools agreed to take part. In total, 447 students responded to a self-report questionnaire sent to them by post out of a possible 739 final year students which represented 61% of the potential population. BDA Advice Sheet A12 (1996) sets out the necessary infection control precautions as do CDC recommendations (1987) and these were utilised to formulate a questionnaire whose items included infection control compliance, knowledge of HIV and treatment of HIV infected patients.

As early signs of HIV infection can be identified in the mouth, Gilbert & Nuttall (1994) put related questions to the students. The majority of students recognised the association between HIV and hairy leukoplakia (97%), HIV and Kaposi's sarcoma (99%) and HIV and oral candidiasis (95%). Despite the high level of knowledge, only 42% believed that the education they had received was adequate. Possible routes of transmission were assessed with 99% recognising the fact that HIV infected blood coming into contact with broken skin poses a real risk of transmission. Sixty-four per cent incorrectly believed that

the saliva of an HIV carrier could also cause infection if exposed to broken skin. Unbroken skin which comes into contact with blood was viewed as another possible route of contamination by 13% of the subjects. Aerosols are often left unmentioned with 76% of subjects reporting that the inhalation of an HIV-infected aerosol could result in infection. Fifty-six per cent of students intended to implement a universal infection control policy in which all patients would be treated as potentially infectious. Despite this finding, 73% went on to say that they would take extra precautions when treating a high-risk patient. The majority of students in this sample complied with recommendations. Eighty-four per cent wore eyewear, 63% masks and 58% routinely wore gloves, changing them between patients. Yet as many as 35% of students would wear the gloves and then wash them before treating the patient. Twenty-nine per cent believed that these barrier measures were inadequate.

Sivarajasingam & Ogden (1995) also looked at the situation in Britain by surveying clinical staff and students at Dundee Dental Hospital, Scotland in 1993. All 70 staff took part and 101 (77%) students from a total of 132 responded to the questionnaire. One outcome measure was focused upon, namely the acceptance of HB vaccination. The details of this measure were obtained from the BDA Advice Sheet in 1996. This investigation revealed that all staff and students who participated were aware of the vaccine's availability. Nine students had not completed the vaccine course, 7 students were undergoing vaccination at the time of the questionnaire and 49% had failed to request a titre check one year after the last dose. Fifty-one per cent had their titre measured after their last dose. The results showed 6 to have had an inadequate response

and thus received a booster. Twenty-seven per cent thought that the vaccine offered lifelong protection, which was incorrect at that point in time. For the staff, 5 staff were undergoing the course but had not yet completed it. Forty-seven requested a titre test of which 7 showed a poor response. Twenty-eight per cent did not bother to arrange a test.

In Africa, **Hartshorne *et al.* (1994)** mailed a questionnaire concerning attitudes and perceptions of AIDS, knowledge of symptoms of HIV infection and the sources of this information. Recommendations by the CDC (1987, 1989, 1991) were utilised. South African dental and oral hygiene students were the focus of this study with 79 dental students and 30 oral hygiene students taking part. Hartshorne *et al.* (1994) found a significant improvement in knowledge between first and second year oral hygiene students ($p<0.05$). For dental students, third year students' ability to identify signs differed from all other dental year groups ($p<0.05$). However, students seemed to have a poor perception of both the risk of infection following a needlestick injury and the risk of infection from the saliva of an infected patient and were unaware of the need to rinse impressions before sending them to the laboratory. Most students agreed that infected patients should have treatment available to them, but would prefer to receive training in the treatment of HIV sero-positive patients within an AIDS unit as only a few students had had exposure to an HIV infected patient.

Assessing the hypothesised increase in knowledge regarding infection control, **Chehaitly & Alary (1995)** selected a sample of third and fourth year dental students from three provincial dental schools in Quebec in 1993. 188 replied to the revised and pretested mail

questionnaire from a total of 307 selected (61% response). Outcome measures such as knowledge and attitudes towards HIV and HBV infected patients, infection control measures taken and perceived risks were included following reference to ADA recommendations (1988) and guidelines produced by the CDC (1991) and CDA (1988).

Overall, a good standard of knowledge was evident, but knowledge pertaining to HBV was better still. In terms of clinical knowledge both third and fourth year student groups failed to perform to the same standard. Compliance with infection control precautions appeared to be high with gloves, masks and eyewear being used for all procedures. The only area of concern was handwashing which only 66% of subjects reported to be doing before and after patient contact. All but one student had been vaccinated against HBV. With this high level of compliance, perceived risk was significantly lower for HIV ($p<0.001$). Ninety-two per cent believed the responsibility for treatment of infected patients lay with each dentist. However, this finding was contradicted by the opinion of 57% that infected patients would be better treated in specialised centres.

Scully *et al.* (1991) posted a questionnaire to all clinical dental students in their final two years at the University of Amman, Jordan (n=120) in 1990. One hundred and nineteen students returned their completed questionnaires, thereby providing information concerning their perceptions of infective risks, acceptance of hepatitis B vaccine and infection control measures which are in place in their dental offices. Despite the fact that no specific guidelines were stated, these issues are recognisable as standard recommendations within the dental profession. The findings presented by Scully *et al.*

(1991) reveal that the majority of respondents knew that a vaccine against hepatitis B was available. Knowledge of the availability of vaccines for other viral diseases such as hepatitis A, C and D and HIV were circumspect. Significant numbers of subjects were unsure of availability. Half of all respondents had been vaccinated against hepatitis B. Unfortunately, only 4% of subjects who remained unvaccinated were considering vaccination. As many as 82% reported sterilising dental instruments by autoclave but 11% failed to respond to this question.

Katz *et al.* (1989) carried out a questionnaire-based survey of all the directors of dental radiology departments in US and Canadian dental schools. Sixty-nine schools were contacted and 62 agreed to participate, completing a questionnaire about infection control in general and the existence of protocols. These measures are outlined by CDC recommendations (1986, 1987) and guidelines issued by the ADA (1982, 1985, 1988).

This survey of US and Canadian schools focused on the radiology department but indicated similar trends to other studies which have been carried out in dental schools in the UK. Ninety-four per cent of the schools which responded had a radiology infection control policy in place. Thirty four per cent of schools had an additional protocol for high-risk patients. When exposing intraoral radiographs, all 62 schools reported that gloves were worn by all students. Other items were used less frequently. Gowns were worn by the staff and students in 73% of schools, masks in 40% and eyewear in only 19% of schools. Three key surfaces are disinfected when preparing, carrying out and developing radiographs. The intraoral operatory, the panoramic operatory and the darkroom surfaces

all come into contact with potentially contaminated radiographs. Fifty-five per cent of schools surveyed reported disinfection of the intraoral operatory after each patient which was also similar for the panoramic operatory surfaces where 61% of schools reported disinfection was completed. Only 3 schools reported disinfection in the darkroom. The disinfectant which proved most popular was iodophor which was used by 39% of schools routinely and 31% for infectious patients.

Corbin *et al.* (1988) performed a similar trial in 1986, studying the knowledge, attitudes and behaviour within US dental schools relating to infection control and HIV. Following recommendations by the ADA (1978, 1985, 1987, 1988), CDC (1985, 1986) and MMWR (1987), Corbin *et al.* (1988) developed a questionnaire to assess these issues and posted one to each of the deans of all US dental schools. Forty-seven out of 55 schools replied. Corbin *et al.* (1988) revealed that all 47 schools who responded provided classroom instruction in infection control and the majority of them (85%) also offered clinical instruction. The time which was devoted to this varied considerably between schools. Despite the time devoted to this issue, only 36% of schools required the students to demonstrate their competence. In 1982, 89% of responding schools reported using special protocols. Fifty-one per cent used a special protocol for high-risk patients, determining the level of asepsis from the patient's diseases status. A waste disposal policy was in place in 66% of schools, needle and sharps' policies in 87% of schools and 77% had a protocol which had to be followed for the reporting of needlestick injury. Policies have to be updated and in 85% respondents indicated that monitoring took place, varying from weekly in some schools to monthly in others.

The majority of schools made services available for high-risk patients with two thirds having isolation facilities for their treatment. In terms of recommendation adherence, the situation had improved from the initial findings from the 1982 survey to the present 1986 results. In 1982, 13% of schools reported routine wearing of gloves, 15% masks and 50% eyewear. In 1986 these figures had increased with gloves being worn in 81% of schools on a routine basis, masks being worn in 72% of schools and 81% of schools using eyewear. Hepatitis B immunisation was a hazy issue for 45% of schools who said they were unaware of the hepatitis B status of faculty and clinical personnel. Amongst schools who had this information available to them, the rates of compliance varied considerably between schools. Surface disinfection was required in two thirds of schools but 11% of schools reported using alcohol despite ADA and CDC recommendations.

Blair & Wassell (1996) carried out a self-report questionnaire survey of all 15 UK dental hospitals in 1995. Heads of conservation and prosthetic departments were contacted, resulting in a 100% response. Following BDA (1987) and ADA (1988) recommendations, Blair & Wassell (1996) developed a questionnaire investigating the types of impression materials used, methods of disinfection, in particular those for high-risk individuals, and any adverse reactions suffered. Blair & Wassell (1996) reported that all dental hospitals in the UK rinsed their impressions with water. Following this, all departments except five then carried out some form of disinfection, although disinfection was also performed in these five when the patient in question was a known high-risk patient. The majority of schools preferred disinfection to be carried out in the laboratory. A wide variety of solutions were reportedly used but sodium hypochlorite proved the most popular, used by

11 departments (37%). Different techniques were employed by the departments. In 7 departments, an impression immersion technique was used, while 25 used the spray and leave technique. Three other departments combined them. The concentrations of sodium hypochlorite being used tended to be in line with WHO and CDC recommendations; immersion times were less closely adhered to with 60% of departments failing to meet the necessary time. Five departments used immersion times sufficient for sterilisation, 13 left the impressions long enough for disinfection to occur, but 12 departments reported immersion times which would be insufficient for disinfection. Adverse reactions to disinfection solutions were noted with metal corrosion and softening of plaster models causing problems. Often different materials were used for high-risk patients as the increased level of disinfection could alter the material.

Scherer *et al.* (1989) detail the findings of a self-report questionnaire sent out in 1986 by the Department of Operative Dentistry in New York University College of Dentistry to the chairpersons of all the operative departments of the 58 US dental schools. Thirty-five out of 58 questionnaires were returned, representing all the geographical regions within the United States. Sterilisation methods were assessed in relation to ADA recommendations. Limited results were produced from this highly specialised questionnaire. Sterilisation methods were addressed and indicated that 75% of stainless steel hand instruments were autoclaved in comparison to 53% of the carbon steel equivalent. Burs were not routinely autoclaved, with only 25% of steel burs being put through this system, 33% of carbon steel burs and 39% of tungsten-carbide burs. Handpieces sterilisation has attracted much attention in recent years. At the time of this

study in 1989, 39% of dentists autoclaved their high speed handpieces, 33% autoclaved their low speed handpieces and 44% sterilised their prophy angle handpieces. Cold sterilisation proved the next most popular option, with fewer using dry heat treatment.

- **Combined surveys of dental team members**

This review has uncovered a number of studies which take a combination approach, looking at a range of dental team members. The surveys offer an indication of the current rate of compliance in USA, Nairobi and the UK. Each differs slightly in its targeted subject groups. **Gerbert *et al.* (1988)** used CDC recommendations (1986) as a basis for the formulation of a questionnaire whose aim was to investigate the knowledge of HIV related issues, attitudes regarding HIV, perceived risk and willingness to treat of licensed dentists, dental surgery assistants and hygienists from California, USA. Six counties were selected within California and the rosters of all DHCWs from State Licensing Boards were obtained. Two hundred and ninety-seven (65%) dentists, 128 (62%) hygienists and 171 (44%) DSAs responded to the questionnaire.

Age appeared as a significant predictive factor. Dentists over 43 years of age were significantly less knowledgeable ($p<0.015$), their attitudes presented barriers to the care of HIV positive patients ($p<0.002$) and they performed fewer infection control procedures ($p<0.002$). Overall, knowledge scores were significantly higher for dentists and hygienists in comparison with DSAs. Despite this knowledge, less than half of dentists and hygienists and only 18% of DSAs had the skills needed to treat HIV positive patients. As

a result, 70% preferred to refer these patients to specialist centres. Modest positive correlations were found between attitude scores and infection control compliance scores for hygienists ($r=0.402$), for dentists ($r=0.229$) and for DSAs ($r=0.227$). Those subjects who judged more patients to be at risk tended to use more infection control measures ($F=9.99$, $p<0.001$). These subjects were also more likely to take a thorough medical history ($F=4.32$, $p<0.02$) and sexual history ($F=3.44$, $p<0.04$). Knowledge scores did not differ in terms of the perceived number of patients at risk.

The investigation of **Kaimenyi & Ndung'U (1994)** instead examined the behaviour of dental auxiliaries which included dental technologists, final year students and dental hygienists, all of whom were surveyed at the University of Nairobi. Only 71 subjects were contacted of which 65 responded (92%). Using the Ministry of Health's AIDS control programme of 1992 as a frame of reference, questions were posed regarding treatment of HIV positive patients, the knowledge and attitudes of dentists to AIDS and their knowledge and attitudes towards related infection control measures. The results suggest that the knowledge of the sampled dentists was lacking in certain areas. Sixty-six per cent of the subjects knew only one or two AIDS-related symptoms from a possible seven. Ninety-one per cent were unable to estimate correctly the period within which someone can develop full blown AIDS. With regard to infection control precautions, several concerns arose. Only 71% used gloves for the treatment of AIDS patients; 59% changed them between patients. Sixty-eight per cent used masks routinely and 43% wore protective eyewear when treating patients known to be carriers. Seventeen per cent believed that boiling water would be sufficient to sterilise contaminated instruments and

40% believed chemicals to be sufficient. The participants' obvious lack of knowledge and confidence is reflected in their attitudes that HIV positive patients should be treated in specialised centres, an opinion which was held by 57% of the sample. Eighty-five per cent believed that all AIDS patients should be treated in similar settings.

Allsopp *et al.* (1997) used a self-report questionnaire as a means of gathering information regarding use of personal protective equipment, method of ventilation, use of equipment to minimise aerosols and the reporting of any work related symptoms. These items were included following consultation with COSHH 1989 guidelines which outlined specific recommendations for health personnel. A cross sectional, longitudinal design was employed to examine a 'random' sample of dental practices in the West Midlands, England. All members of the dental team were targeted. Family Practitioner Committee lists of Birmingham and Solihull were used for recruitment purposes. In total, 122 dentists, 86 hygienists, 115 DSAs and 74 receptionists replied. 30 hygienists from a similar pilot study 5 years earlier were also included in the analyses and paired analyses of the data enabled changes in behaviour to be detected.

Significant differences in the use of PPE amongst dental team members were revealed by Allsopp *et al.* (1997). Significant differences were also apparent in the use of masks between the clinical staff groups being surveyed - dentists, dental surgery assistants and hygienists ($p<0.001$). DSAs' simultaneous use of masks and glasses was shown to be significantly less than the other groups. However, it is not clear whether receptionists were omitted from this analysis. Simultaneous use of masks and glasses was reported by

44% of hygienists. This was significantly ($p<0.001$) higher than the 15% of dentists who did so. Not one DSA was recorded as using both of these items. Mask use had increased for all clinical groups, although the proportion of DSAs who indicated an increase was significantly lower than the dentist and hygienist groups. Use of glasses had increased for DSAs and even more so for dentists ($p<0.001$). Hygienists, on the other hand, reported no overall increase.

The paired analysis of data for hygienists in the present study and those from an earlier pilot study revealed an increase in PPE use, rising from 54% to 71%, although this difference is not statistically significant. The use of PPE did not differ significantly between the 33 participants who had also taken part in the pilot study five years earlier and those who were participating for the first time, indicating that the pilot study had no effect on the subjects' behaviour and that the increase noted was probably a general trend.

Using a pretested questionnaire, **Hastreiter *et al.* (1990)** tried to assess the knowledge, attitudes and clinical practices (KAPs) regarding infection control in relation to MMWR (1987) recommendations of several subgroups within the dental team. In 1988, dentists, hygienists and registered DSAs from Minnesota were surveyed. Four hundred and thirty-eight of 631 (69%) dentists completed and returned their questionnaire as did 439/603 (73%) hygienists and 384/691 (56%) DSAs. These subjects were drawn from populations of licensed dentists (total 2869), hygienists (1891) and registered DSAs (3086) within the state of Minnesota in 1989. No method of selection was described.

DSAs and hygienists surveyed in Minnesota reported high compliance with the recommendations. Over 80% of participants in each group wore gloves routinely, changing them between patients and washing their hands before and after use. Of the two groups, hygienists were significantly more likely to wear gloves, change them between patients and wear masks and a face shield ($p<0.001$) perhaps due to the fact that hygienist duties require more direct patient contact. DSAs were significantly more likely to have sustained a needle stick injury within the previous 12 months ($p<0.001$). However, not one DSA and only 11 of the 22 hygienists who found themselves in these circumstances sought serological follow-up testing. A possible reason for these injuries is the fact that 72% of DSAs and 65% of hygienists continued to recap needles without protection and to dispose of needles in non puncture resistant boxes. Control over infection control policy in practice was viewed by 55% of DSAs and 51% of hygienists to be in the hands of the dentists. As many as 71% of DSAs and 75% of hygienists were willing to treat HBV infected patients in practice but these figures were considerably lower for HIV carriers with only 43% of DSAs and 47% of hygienists being willing to do so. Only 5% of DSAs and 8% of hygienists believed that the practice was a suitable place to treat a high-risk patient of this type.

Education is of paramount importance in this field and one needs to stay abreast of any changes. Sixty-five per cent of DSAs in this sample and 61% of hygienists had attended a course relating to infection control during the previous year. Only 36% of DSAs and 46% of hygienists had enough information, in their view, to adequately treat HIV positive

patients and 33% of DSAs and 47% of hygienists were familiar with CDC recommendations.

Hastreiter *et al.* (1992) extended their investigation taking into account information from dentists. Subjects were drawn from populations of licensed dentists (n=2869), licensed dental hygienists (n=1891) and registered dental assistants (n=3086) in 1989, all of whom worked in the State of Minnesota. Sample sizes were calculated in order to achieve a minimum 60% response rate. Each revised and pretested questionnaire was given a confidential ID number and following an initial mailing, a postcard reminder was sent to all non-respondents two weeks later. Sixty-nine per cent of dentists, 73% of hygienists and 56% of dental assistants returned their questionnaires whose characteristics were consistent with known distribution of DHCWs in Minnesota.

Hastreiter *et al.* (1992) found that 62% of their sample of dentists, DSAs and hygienists had attended a continuing course relating to dental infection control. Following this, 57% reported being knowledgeable or 'very' knowledgeable about this field. Within the dental office, there seemed to be differing opinions as to who was the primary infection control decision maker. Eighty-two per cent of dentists believed they assumed the primary role however only 53% of hygienists and 49% of DSAs were in agreement. The remaining DHCWs believed that infection control was decided upon collaboratively. Hygienists were significantly more inclined to wear gloves, change them between patients, wear masks when splashing was likely and wear protective uniform than dentists and DSAs

($p<0.05$), with dentists proving the least compliant group. Younger dentists were also significantly more likely to carry out these measures in comparison with older dentists.

Generally, gloves were the most routinely used barrier measure by DHCWs followed by washing hands, wearing masks, wearing eyewear and wearing protective uniforms. The fact that 60% of dentists, 63% of DSAs and 53% of hygienists recap needles without using the appropriate protection explains the result that dentists and DSAs are significantly more likely ($p<0.05$) to have sustained needlestick injuries. Understandably, DSAs and hygienists were found to be significantly more likely ($p<0.05$) to have suffered puncture wounds from instruments. Of 4 dentists, 16 hygienists and one DSA exposed to HIV by these routes, only 2 dentists and 5 hygienists had actively sought serological follow-up testing. Given these findings, 44% of dentists' practices, 29% of hygienists' and 33% of DSAs had acted according to practice protocol for occupationally acquired injuries. Fifty-one per cent of dentists, 40% of hygienists and 33% of DSAs believed they had sufficient information to treat high-risk patients. However, 51% of dentists, 67% of hygienists and 77% of DSAs were unable to correctly state the risk of infection of HIV from a needlestick injury as less than 1%. Those who correctly answered this question were more likely to have treated high-risk patients and be more willing to do so. More subjects from each of the three groups believed a greater ethical responsibility to treat high-risk patients and less of a legal responsibility. Sixty-two per cent of DSAs, 45% of hygienists and 22% of dentists believed that mandatory HIV testing for all patients before treatment should be put in place.

Jacobson *et al.* (1989) gave lectures and seminars at Michigan School of Dentistry, USA between 1984 and 1985. Students, faculty and staff were invited to participate in a hepatitis B vaccination programme, thereby assessing the efficacy of the programme and its uptake. At the end of the programme, a pretested questionnaire was given to participants in the trial and non-participants whose questions were based on ADA (1982), CDC (1983) and OSHA (1983) recommendations as well as regional health department guidelines. Six hundred and sixty-seven subjects took part which consisted of 93% of the student population, 51% of faculty members and 29% of other staff, producing an overall 69% acceptance rate. Three hundred and twelve potential subjects did not participate.

Jacobson *et al.* (1989) uncovered several findings which offer some insight into the reason for some dentists accepting hepatitis B vaccination and others not. An association was identified between participation in the programme and patient contact ($p<0.001$). The less patient contact time, the less likely one would be to participate. Participants in the study were more likely to report a feeling of susceptibility to hepatitis B and feel that contracting the disease would have a significant effect on their lives. The participants clearly believed that the vaccine was more effective than those who chose not to be vaccinated, and the idea of scheduled appointments proved a cue to action for many participants. On the other hand, the non-participants were more likely to see barriers to taking part, such as the cost of the vaccine, the time involved and unknown side effects. Jacobson and his colleagues performed stepwise logistic regression analyses on the data to determine any predictors of vaccine acceptance. Factors such as susceptibility to hepatitis B, the perceived severity of the disease, the cost of the vaccine and access to it had a

predictive effect of acceptance. The age of the potential subjects and their status within the School also affected their likelihood to participate. Those subjects older than 45 years had significantly lower perceived severity of hepatitis B ($p<0.001$).

This selection of papers indicates the heterogeneity present in this area of research not only in terms of targeted subjects and outcomes but also sample sizes and population origin.

Methodological Quality of Included Studies

A set of quality criteria for potentially valid studies was developed by the research panel who assessed factors such as the number of participants in the study, the reliability of the responses and the effect of non response bias. Potential studies were limited to randomised controlled trials, controlled clinical trials, controlled before-and-after studies and interrupted time series studies. Papers studying observed behaviour or self-reported behaviour were also considered to be of importance. However, one ought to keep in mind that self-reported behaviour is fraught with potential bias. These studies were therefore considered separately from the more methodologically sound alternatives and comparisons were drawn between the two types to determine if the method of response has a significant effect on the information given. Glove use and changing between patients, the wearing of protective clothing, protective eyewear, the autoclaving of instruments and handpieces in between patients, the disinfection of surfaces and hepatitis B vaccination were the outcome measures under assessment.

Cochrane Review

Literature search

Database searches produced 2,420 articles of which 1,985 were excluded on screening. Upon review of the titles and abstracts, only one met the selection criteria in terms of study design. After obtaining a hard copy of the full text review, the study was found to have employed a self-report questionnaire for the recording of outcome related information. The fact that the measurement tool was not objective was noted and was taken into consideration when interpreting the findings of the study. No additional relevant studies were identified from other sources.

Targeted behaviour

The targeted behaviour in all trials was the adherence to guidelines i.e. a relationship between knowledge, attitudes and actual behaviour. This review compared adherence pre and post intervention.

Characteristics of participants

The single trial was based in San Francisco, United States. In this trial the targeted health professionals were licensed dentists. These participants were identified by inviting all dentists licensed and practising in San Francisco to participate. They were subsequently required to sign a consent form. The trial employed a questionnaire which had been

developed by Gerbert and her colleagues and used in previous work (1987). For this study the questionnaire was both adapted and updated in order to collect the relevant information at baseline. To gather the necessary information, 2 knowledge scales, another scale focusing on attitudes and two further scales measuring behavioural outcomes were used. In a study by Gerbert (1988), 107 dentists from a total population of 700 agreed to participate (15%). Of those who volunteered, 91% were males with a mean age of 41.4 years. Ninety-five per cent of participants were general dental practitioners with the remainder practising in specialities.

Characteristics of interventions

In this trial, the intervention consisted of three elements which took place during a six month period. The subjects primarily completed the questionnaire to ascertain a baseline measure of the outcome variables under investigation. The first strand involved the mailing of information bulletins. These bulletins were tailored according to the subjects' responses on the questionnaire at pre-test. As a result, areas needing attention were highlighted. These included epidemiology, basic science, clinical science, oral manifestations of HIV infection and AIDS, as well as psychosocial and legal issues. The second component involved a feedback form detailing the individual subject's scores according to the outcome variables. Encouragement or details of possible improvements were given when warranted. The third element of the intervention involved the dentist participating in a conference call along with 5 or 6 others (within the trial) and experts from the University of California, San Francisco. Bulletins were reviewed, questions answered and discussion encouraged. The conference call lasted for approximately one

hour. 36 subjects received the intervention and 66 subjects were assigned to the control group.

Results

Only one comparison could be drawn from the potentially valid studies uncovered by the search, namely that the intervention had an effect on the dental team's adherence to infection control guidelines in comparison to no intervention. The baseline questionnaire scores for subjects in both experimental and control groups showed no significant differences ($p>0.05$). The effectiveness of the intervention in increasing questionnaire scores relating to knowledge of information about HIV and AIDS and related infection control behaviour was statistically significant in comparison with the controls who received no intervention ($p<0.05$). Significant changes occurred in favour of the experimental group for all 5 outcome variables. At baseline, scores on the questionnaire showed no substantial differences. However, at post-test, despite the fact that controls' scores had improved for 3 out of 5 outcome measures, the increase for these outcomes in the 'treatment' group was significantly more. No indication was made as to any specific element of the intervention provoking these changes and having a particularly influential role or whether the combination of the three components was the reason for an effect being noted.

Methodological quality of included studies

In relation to the single potentially valid trial, allocation to groups was described as randomised, using a computer generated list. Thirty-six subjects were assigned to the experimental group and 66 acted as controls. No specific reason was given for the considerable diversity between the numbers in each group, although financial considerations could be a possibility. This study faces considerable criticism due to its failure to utilise an objective form of measurement for outcome measures. Instead, a self-report questionnaire was used. The related biases have been considered when analysing the results. Blinding of the outcome assessment was not described as concealed in this trial and was therefore recorded as not clear on the quality assessment form. No follow-up of the participants was described, rather measures of the outcome variables were made only at baseline and again six months later at the culmination of the educational intervention.

Strength of evidence for the desired change in practice

The results of the literature review speak for themselves as only one trial was considered primarily eligible for the review. This suggests that the standard of research in this field may be feeble and requires improvement. Review of excluded articles, which include surveys and observational studies, strongly suggests that dental team members may not be adhering strictly to the guidelines. This finding needs to be addressed.

CHAPTER V

DISCUSSION

NHS R&D Review

The present review set out three main objectives: first, to determine the knowledge and attitudes of GDPs towards infection control procedures, second, to determine the practising behaviour of DHCWs in respect of infection control and third, to determine whether a relationship exists between knowledge, attitudes and behaviour (e.g. adherence to guidelines).

Within the field of dental research, the searching of electronic databases for both published and unpublished trials, correspondence with experts and the scanning of references uncovered an encouraging number of studies related to infection control. Many of these studies, however, focused on the biological testing of infection control measures which are presently in place and others offered summaries of related topics rather than being experimental in nature, and were therefore excluded. As this review stipulated the inclusion of randomised controlled trials (RCTs), clinical controlled trials, controlled before and after studies (CBAs), interrupted time series studies (ITSs), observational studies, surveys and reports of infection control procedure uptake only, the group of potentially acceptable studies was reduced from 435 to 71.

Methodological Issues

Systematic reviewing is a relatively new scientific methodological technique which essentially enables the results of a range of studies, investigating a key topic, to be integrated in order to assess the consistency of the findings. The initial stage in the review is the defining of inclusion criteria to be used for assessing each study. Developing inclusion criteria enables large, unmanageable amounts of information to be reduced to the essential studies whose findings are reliable. By focusing on studies of rigorous experimental design, the reliability of such a review is increased considerably as bias is limited and the accuracy of the overall conclusions is improved. The searching for studies requires a search strategy which is sufficiently sensitive to identify all related trials yet also sufficiently selective to limit the search to potentially valid studies. Such strategies require extensive preparation as key areas can easily be missed or left untouched. The indexing of studies can often be inadequate, therefore supplementary measures to simple database searching are needed. For example, double checking for missed studies by scanning reference lists in those articles uncovered is time consuming, but it adds weight to the reliability of the review. Independent assessment of each study by two reviewers likewise increases the reliability of the work, producing a true summary of the available data as opposed to a simple manifestation of the authors' opinion.

Data extraction and analysis follows, demanding careful duplication of the results and analyses performed, in order to make an assessment. This part of the process proved problematic for the data available in this field. The involvement of different subject

groups from a variety of settings, using a range of measurement tools within the included studies made the possibility of quantitative statistical analysis futile. Quantitative analysis aims to increase the precision of the estimates of effect and to reveal whether consistent results exist in the field's literature. However, this set of data proved too heterogeneous in nature for such analysis to be worthwhile, thus qualitative synthesis was performed instead. The information derived from this type of review can be used by clinicians and health policy makers in the process of guideline, policy and legislation formulation.

The reliability of the findings of this particular review is compromised, however, by the types of study design which have been applied by researchers in this field. By dividing the data set according to study design, the strengths and weaknesses of each design were highlighted. The literature uncovered in the field of dental infection control is particularly biased. By far the most frequently applied design is the questionnaire-based survey. This type of survey is based on self-report measures of knowledge and attitudes - concepts which themselves are highly untenable - as well as behaviour relating to infection control. By including studies of this design which differ from each other in terms of criteria, definitions of disease, methods of measurement, forms of treatment and outcome measures, it proves very difficult to produce any accurate conclusions. The nature of the study design itself introduces possible selection bias and the inherent problems of non-response. For this reason, attempts have to be made to ensure that non-respondent data do not differ significantly from respondent results. The questionnaire as the standard method of measurement is fraught with potential biases given that the self-reporting of attitudes

and behaviour can lead to an overestimation of socially desired responses (Adams et al. 1999).

Two studies carried out by Scheutz & Langebaek (1995) and Lloyd et al. (1995) tried to deal with this problem and increase the objectivity of their study by combining a questionnaire with another measure (an autoclave indicator strip and an educational TV documentary respectively). Interview surveys appeared on three occasions as did observational studies. Observational studies may initially be thought of as more reliable, but this design can also encounter problems in terms of poor design, susceptibility to biases and lack of objective measurement. Despite the fact that the scales are developed by which behaviour can be measured, humans are inherently subjective and this can often encroach upon the recording of the data. To address this issue, video cameras could be fitted in surgeries but this introduces a range of ethical implications. The presence of an observer can itself modify the behaviour of the subject and produce a false result. This offers an idea of the limitations in this essential research field arising from the problems of assessment.

The severe lack of rigidity of available studies is made clear by the fact that only one study exists which attempts to manipulate the situation in order to test the possibility of improving a less than acceptable rate of compliance with regard to cross-infection control. A randomised controlled trial by Gerbert et al. (1988) fulfilled the pre-specified criteria, in terms of design and methodology and those additional criteria specifically developed for this review. However, despite its supposed gold standard status in terms of

design, its quality was compromised for a number of other reasons. The highly selected sample of participants introduced bias as did the fact that only a very small proportion of dentists from the San Francisco area were represented. By using volunteers, it is little surprise that the intervention group improved their infection control knowledge given their willingness to participate. Furthermore, the subjectivity of the method of measurement and the omission of key details reduced the reliability of the findings. Therefore it is evident that the standard of study design is not suitably robust if reliable findings are to be found. There is a clear need for a shift in focus in terms of the method of measurement being applied to assess the compliance of DHCWs to guidelines. A greater observational element within studies may be one possible way of reducing the bias, yet this too has its problems. What is certain is that questionnaire surveys, unless optimally designed in terms of participant numbers, the response rate, questionnaire design and the generalisability of the results, can offer little more to this field of research.

Qualitative Analysis

Dentists' knowledge of infectious diseases and the necessary infection control procedures is vital. Research has therefore been aimed at assessing compliance by the dental team with a variety of recommended infection control procedures and to estimate the knowledge and attitudes of the dental team towards blood borne diseases and the precautionary measures to prevent transmission. Dental students, in particular, form the basis of knowledge and understanding for the future. Therefore, research has been carried

out both to assess the knowledge of the dental team regarding infection control and to pinpoint any factors which may be associated with adherence to guidelines.

Guidelines relating to infection control are constantly being adapted and modified according to new scientific findings. Guidelines today are much more rigorous and extensive in relation to those in the early 1980s. Due to these developments, the results of each of the studies must be considered in relation to the guidelines in place at that time, making the comparison of studies all the more difficult.

Knowledge and Attitudes

The general level of knowledge of dentists appears to be adequate. The results of studies by Angelillo et al. (1994), Snyder (1993) and Gilbert & Nuttall (1994) suggest that dentists' knowledge of the signs and symptoms of HIV infection in the mouth is good. Any problems seem to be centred on specific aspects of infection control. For example, the potential routes of transmission of HIV seem to cause problems, as many incorrectly believe that saliva is a principal means of infection. A second example is the lack of awareness that measures taken against HBV transmission are sufficient for HIV; only 50% of a sample being aware of this fact is unacceptable. This lack of knowledge may explain why many dentists take extra precautions for the treatment of HIV carriers despite the fact that this contradicts the principal guideline of infection control : to treat all patients as potentially infectious.

Specific failings in recommended infection control procedures vary from country to country. This world-wide review indicates that in Africa, as Kaimenyi & Ndung'U (1994) portrayed, the dentists had poor knowledge of basic infection control procedures. The subjects seemed unsure of the correct protocol, 17% believing that boiling water was sufficient to kill blood borne viruses and a further 40% believing that chemicals could be used for sterilising purposes. Circumstances are clearly very different in countries where the necessary finances are not available, but knowledge is power and dentists should be aware of the facts.

Several associations were found between the dentists' knowledge and other variables. Dentists who are less well informed are more likely to perceive there to be a higher risk of infection as a result of their lack of awareness. The results of the study of Angelillo et al. (1994) suggested that the poor knowledge of some dentists was due to their lack of contact with high risk patients. Ter Horst et al. (1989) also found a significant association between those who were less well informed and an increased expression of fear. Evidently, this vicious circle of lack of knowledge and restricted patient contact can lead to a higher perceived risk of infection and fear which, in turn, produces avoidant behaviour and reinforces beliefs. In addition, a relationship was uncovered linking knowledge scores and years in practice. It seems that dentists who have been practising dentistry for longer are less familiar with infectious diseases and infection control. Twenty years ago, dental students carried out treatment without wearing gloves or taking many of the measures now considered standard practice. These dentists continue to need encouragement to review their infection control routines.

The notion that patient contact influences one's perception of risk of infection finds support in the apparent association between practice locale and one's willingness to treat a high risk patient. Kunzel & Sadowsky (1991) and McCarthy et al. (1996) both found that the situation of the practice was a contributing factor in their dentists' attitudes. In the study by Kunzel & Sadowsky (1991), dentists working in cities were more likely to be willing to treat high risk patients, perhaps as a result of the knowledge they had gained from working with infected patients. Furthermore, McCarthy et al. (1996) found that dentists practising in suburban areas were less likely to be prepared to treat infectious patients. The attitudes and knowledge of the dental team determine their compliance with infection control procedures in general. It perhaps would prove most effective to improve knowledge, thereby changing attitudes in order to achieve the ultimate goal of improving adherence.

The willingness of dentists to treat high risk patients continues to vary considerably (Scheutz & Langebaek (1995), Bray & Chapman (1990), Hudson-Davies et al. (1995), Cohen et al. (1997) and Hastreiter et al. (1990). By identifying mediating factors, researchers hope to develop a means of intervention. In general, dentists have perceived the risk of infection to be small (Scheutz & Langebaek (1995), Hellgren (1994) and Bray & Chapman (1990)). However, findings suggest time upon time that a significant proportion of dental team members feel that the dental practice is not a suitable setting for the treatment of high risk patients (Kunzel & Sadowsky (1993), Hastreiter et al. (1990)) and would prefer to refer such patients to specialised centres (Matthews (1989), Bray & Chapman (1990), Kaimenyi & Ndung'U (1994)).

Barrier Techniques

The findings of Mitchell & Russell (1989), Kunzel & Sadowsky (1993) and Gershon et al. (1998) suggest that a high proportion of dentists believe barrier measures, which form part of universal guidelines, are an effective means of preventing the transmission of blood borne viruses. Compliance may be viewed favourably, but members of the dental team do not always appear to act accordingly.

Routine use of gloves, masks and glasses for the treatment of patients in order to protect both dentist and patient has become standard practice over the years. In general, gloves are by far the most commonly used item, according to the studies reviewed, while masks and glasses are consistently worn less often, with protective eyewear proving the least popular item. When one takes a closer look at the findings, it becomes apparent that the rate of adherence to recommendations for barrier measures has increased over the years as guidelines have been introduced and modified. Recent studies carried out by Walsh et al. (1995), Lange et al. (1996) and Cohen et al. (1997) found high rates of routine glove use (>80%) in contrast to poorer rates displayed by studies carried out by Scully et al. (1992) Mitchell & Russell (1989), Matthews (1989), Bray & Chapman (1990) and Burke et al. (1991) at the end of the 1980s and early 1990s.

A definite increase in glove use, over the years, has been indicated by follow-up studies as recommendations have been extended and made more explicit. For example, Verrusio et al. (1989) found that 23% of GDPs who wore gloves in 1986 had increased

dramatically to 76% when the questionnaire was sent out for a second time in 1988. In support of this, Bednarsh & Connolly (1990) published findings of a similar increase during the period of 1986 to 1988. The evident change is to be welcomed. However, the far from perfect results suggest that there is much room for improvement. How can this problem be tackled? The evidence pinpoints possible reasons for inadequate compliance. Many dentists reported using gloves for selected procedures only, most notably for extractions and scalings when one would be most likely to come into contact with blood, and others for selected patients only. Recommendations have tried to tackle these issues and to convey to dentists that not only are there other procedures such as conservation which bear risks for the dental team but also that patient selection is far from reliable, given that the only information which tells one patient apart from the next is their self-reported medical histories and these are highly unreliable. Yet, some dentists continue to ignore these safety precautions.

Familiarity with and understanding of the guidelines is not likely to be the sole reason for dentists' non-compliance. Dentists who respond to questionnaire studies say that cost and time constraints are two of the determining factors in the decision to follow guidelines (Mitchell & Russell, 1989). To address this problem, however, there is a clear need for the policing of the implementation of guidelines. Many countries have put in place inspection systems in order to check the level of infection control within individual practices. However, shortcomings of these systems may be preventing adequate assessment of infection control. For example, in the United Kingdom, dental practice inspections are carried out infrequently and are performed by fellow dentists who offer

their services to their local Health Board. The system could benefit from an increase in the rate of practice inspections and an 'on-the-spot' approach, thereby offering no time for dentists to 'cover up' mistakes. The reliability of the outcome of current inspections is also compromised by the fact that they are carried out by other dentists. Ideally, an independent body should be set up to deal with these duties and assess all practices by the same standards.

Studying personal protective equipment (PPE) use by subject group reveals differing results according to the role of the team member. Although each dental team member is required to carry out different duties, today's policies encourage uniform use of PPE for all. Needless to say, this is not the case. Dental surgery assistants, for example, play a central role in the infection control process, yet their compliance with guidelines is less than adequate according to the results of this review. Dentists and hygienists tend to use barrier measures more regularly than DSAs which may simply be a result of DSAs' lack of direct patient contact. Nevertheless, formal training and certification is equally essential for DSAs as it is for other members of the dental team to ensure a sound knowledge and understanding of all aspects of infection control. In the United Kingdom, the training of DSAs is considerably less rigorous than in the United States. An overhaul of the present training appears to be required if the current findings are to be improved, perhaps using the American system as a model for change.

When comparing specialist dentists' and GDPs' use of PPE, differences are evident. Several studies, for example Woo et al. (1992), stated that orthodontists were less

compliant with barrier measures compared with GDPs yet, as Verrusio et al. (1989) described, orthodontists in their sample reported higher rates of glove use in 1986 and again in 1988 in comparison with GDPs. The compromising effects of survey study design ought to be kept in mind when interpreting these results, yet justification can be suggested for both sets of results. Orthodontists may, on the one hand, be less compliant as their speciality requires them to treat children who they may feel are of little risk. In addition, this specific form of dentistry involves relatively little blood contact but gloves can easily be torn by the standard equipment being used. On the other hand, orthodontists tend to be situated in a town or city practice which brings with it a greater register of patients and therefore an increased likelihood of coming into contact with high risk patients. This is simply speculation as there is no definite answer to this conundrum. Nevertheless, it helps to show the differing behaviour of dental team members and to relay the inconsistency of results in this field.

By observing dental students and staff in their normal environment, Porter et al. (1995) recorded an almost perfect rate of adherence, though the dentists themselves performed less adequately on both occasions, suggesting that adherence may lapse after a period in practice as constant reminders are no longer present. Compliance with infection control which is enforced at dental school has to be extended into practice life and attendance at educational courses is one possible means of achieving this. The findings of this review consistently associate increased compliance with infection control measures and enrolement at such courses (Manz et al. (1994), Ashton et al. (1994)).

Synthesis of the present findings suggests that lack of barrier protection use tends to be associated with older male, single handed practitioners who practise in suburban areas (Burke et al. 1992). These results offer several lines of inquiry to be followed and target groups requiring intervention. It is easy to say that dentists, if informed of guidelines, should follow them but it is far from being realistic. There must be reasons for dentists behaving otherwise. This analysis has uncovered a general feeling amongst dentists of unreasonable financial outlay and heavy time constraints which put added pressure on an already busy environment. Many dentists report a feeling of loss of sensation when wearing gloves. There is little which can be done to resolve this problem. Dental-regulatory bodies can only rely on dentists believing that the protection the gloves offer outweighs their discomfort. As this review will discuss, barrier techniques represent but one of many infection control precautions in place in dentistry today.

Immunisation

With the realisation of the actual risks involved in dental surgery, attempts were made to develop some form of vaccine to protect dentists against infection. A hepatitis B vaccine became available and was fully recommended to health care workers in 1988 (Goldberg & McMenamin, 1998). As it is an easy way of reducing the risks involved, dental-regulatory bodies and organisations have since unanimously recommended that each dentist and their dental team be vaccinated. In the early days of infection control, as we now know it, Matthews et al. (1986) revealed that 148 dentists out of 218 dentists remained unvaccinated while 55 dentists had completed the course and another 15 were

undergoing treatment at that time. These initial figures are of concern in today's climate of infection control but were respectable at that time. Many dentists feared becoming infected with HIV because, at that time, a plasma derived vaccine was in use. Furthermore, the possible side effects had received relatively little attention and therefore an air of uncertainty surrounded the vaccine. With those factors in mind, dentists were sceptical about the effectiveness of the vaccine and whether acceptance was a risk worth taking. Others simply remained unaware of the availability of the vaccine. As time has passed and the importance of infection control has grown, more and more dentists are adhering to the guidelines. As Bednarsh & Connolly (1990) demonstrated, the uptake of the vaccine increased during the 1980s, rising from 42% acceptance in 1986 to 59% acceptance in 1988 amongst their sample of Massachusetts dentists. Similar findings were published by Evans (1989) while 62% of the dentists surveyed had been vaccinated. More recent studies by Hudson-Davies et al. (1995) and Cohen et al. (1997) indicate the continuing rise in adherence by dentists. In South Africa, Naidoo (1997) found 79% of dentists to be protected. Despite this consistent rise in acceptance, certain key problem areas persist. Both Naidoo (1997) and Sivarajasingham & Ogden (1995) highlighted the low numbers of dentists returning to have their titre levels checked following the last dose of vaccine. Sixty-eight per cent of those vaccinated failed to do so in this study and 49% of vaccine acceptors in the Sivarajasingham & Ogden (1995) study did the same. It seems that the dentists are unsure of the necessary steps to take and require more detailed and salient information. The misinterpretation is also evident by the fact that many dentists believed (incorrectly at that time) that the protection offered by the vaccine was lifelong.

From the studies which have investigated this aspect of infection control, the majority have focused on the dentists themselves, but the immunisation of their dental team is equally important. The figures consistently indicate a reasonably high level of compliance by dentists but a reduced compliance by their staff. For example, McCarthy & MacDonald (1997) found that 61% of the dental team had been vaccinated compared with 92% of dentists. One may think that dentists would influence the behaviour of their staff, yet these findings suggest instead that interventions should perhaps focus on providing the staff themselves with the information necessary to form an opinion, rather than relying on the dentist to do so.

In order to highlight target areas for intervention, studies attempted to uncover predictors and determining characteristics for the acceptance or non-acceptance of the HBV vaccine. Razak et al. (1991) found no convincing differences in terms of the characteristics of the two groups studied. However, Jacobson et al. (1989) suggested that vaccine acceptors were more likely to believe they were susceptible to this infection and to believe the vaccine is an effective form of prophylaxis. Non acceptors, on the other hand, were more likely to have considered the financial cost, possible side effects and the time involved to have more importance. One possible means of improving the rate of vaccination would be to increase the level of occupational health support offered to the dental team. Rather than the staff visiting a health clinic, the vaccination programme could be offered to each dental practice by a visiting health officer who could have the opportunity to inquire about the HB status of the dental team members and to offer

detailed information regarding follow-up. Clearly, such a scheme would bring with it large financial demands, but its advantages may well outweigh its costs.

Sterilisation and disinfection

Sterilisation and disinfection attract a great deal of attention in the field of dental infection control and are the focus of many studies, discussions and policy formulations. Blood borne viruses such as hepatitis B and C and HIV need to be heated to 134 degrees Celsius for at least three minutes before sterilisation can be assured. A wide range of sterilising methods is available, each with its own drawbacks, but the autoclave is considered to be one of the most reliable. Guidelines have been issued by dental governing bodies encouraging its use. Chemical methods of sterilisation can be particularly abrasive, damaging the instruments as well as being time consuming and unreliable. Autoclaves, likewise, can have detrimental effects on the instruments, reducing their functionality. Yet the need to adhere closely to time requirements and chemical concentrations when using solutions means there is perhaps more potential for failure.

With increased reliability come increased costs for the autoclave and its maintenance, an increase in the time limitations it imposes and the detrimental effect it can have on dental instruments. The review of results indicates a consistently high rate of autoclaving of hand instruments. Howard (1989) found that in 97% of practices their hand instruments were sterilised. This high rate of compliance was repeated in the study of Scheutz &

Langebaek (1995) in which 94% used an autoclave for sterilising hand instruments while Treasure & Treasure (1994) found that in 92% of practices surveyed in New Zealand, an autoclave was available.

In recent years evidence has mounted which indicates the additional need for handpiece sterilisation. Consequently guidelines have been developed. Before the intense media coverage of handpiece sterilisation, Bray & Chapman (1990) found high numbers of dentists continuing to disinfect their handpieces. Adherence with related guidelines improved in the years to follow as Treasure & Treasure (1994) showed when 43% of dentists autoclaved handpieces. In the case of the study by McCarthy & MacDonald (1998), the results indicated an increase in compliance from an already high rate of 83% in 1994 to 93% in 1995. A much poorer rate of adherence was found in a fairly recent study by Razak & Lind (1995) in Malaysia. Only 7% of dentists sterilised their handpieces after each patient while 82% continued to use disinfectant. Lloyd et al. (1995) investigated the sterilising of handpieces and the problems which can act as barriers to their use. Many dentists who autoclaved handpieces had noted deterioration in the functioning of the handpieces and those who did not own autoclavable handpieces used this as justification for their actions. Due to their expense, dentists have a limited number of handpieces, which makes sterilisation between patients both time consuming and impractical, as well as exposing the handpieces to added wear and tear. In order to rectify the situation, government subsidisation may be necessary if dentists are actually to adhere to these recommendations, given that financial concerns may be at the root of this problem.

The range of guidelines and recommendations currently in place include measures for the disinfecting of clinical work surfaces, the chair switches, light handles and bracket tables, all of which can come into contact with contaminants. One area of disinfection which is often overlooked involves impressions. Four studies made reference to this aspect of infection control and their findings indicated consistently inadequate practising behaviour. Epstein et al. (1995) and Evans (1989) showed that dentists tended to rinse impressions but failed to follow it with a disinfection regime. Of those who did attempt some form of disinfection, the majority used glutaraldehyde solution, which can alter the dimensions of alginate if immersed for the necessary thirty minutes needed to achieve disinfection. This situation is far from ideal and may result in impressions being submersed for a sub-optimal time period.

Waste disposal and occupationally acquired injuries

Waste disposal is an equally important issue and was studied in New Zealand by Treasure & Treasure (1994). They compared dental practices in Auckland with the rest of the country. Their results were of concern as they revealed that cotton rolls are placed in paper bins and clinical waste often ends up in the household refuse. The findings also appeared to differ according to practice locale. Only 14% of Auckland practices disposed of sharps in the household rubbish compared with 24% of practices throughout New Zealand who did so. This behaviour is totally unacceptable, highly dangerous and contravenes all related legislation. Significantly more practices in Auckland (76%) used a

specialised firm for waste collection than those across the rest of New Zealand (45%) ($p<0.001$).

According to universal guidelines, used needles and sharps should be placed in puncture resistant containers. This review indicates inadequate compliance with this particular recommendation. Hastreiter et al. (1990) found that significant numbers of DSAs and hygienists failed to use special containers as did Ter Horst et al. (1989) whose results showed that in 54% of practices special containers were used for the disposal of sharps. In addition, a number of studies pointed out that clinical staff continued to recap needles without protection, before disposing of the needles. Hasteriter et al. (1990) found that 72% of DSAs and 65% of the hygienists surveyed were prepared to take this risk. Consequently, it is little surprise that many needlestick injuries are sustained each year in the dental surgery. As many as 60% of Danish dentists in Scheutz & Langebaek's (1995) study had suffered a needlestick injury during the previous 12 months. This trend was mirrored in Razak & Lind's (1995) study where 31% of dentists reported suffering 1-3 injuries during the last year. Differences in needlestick injuries and puncture wounds were analysed between subject groups, highlighting orthodontists and DSAs as being more likely to have suffered injuries. The findings of Hastreiter et al. (1990) suggest that DSAs are more likely to suffer an injury than hygienists while Woo et al. (1992) found orthodontists to suffer an injury once every four weeks in comparison with once every ten weeks for GDPs. This is all the more worrying in light of the poorer infection control regimes employed by orthodontists. Gershon et al. (1998) highlighted the possibility of other types of injury with 28% of dentists surveyed reporting parenteral or mucoutaneous

exposure within the last 6 months. Many of the studies report the failure of clinical staff to report or to log their injuries. It is also essential for serological follow-up testing to be sought yet Hastreiter et al. (1990, 1992) revealed the low numbers of staff who actually received the appropriate follow-up. The issue of follow-up to occupationally acquired injuries may also benefit from an increased level of occupational health support which aims to advise clinical staff of risk management programmes which can minimise the hazards they face on a daily basis (Scottish Office, 1998).

Precautions can be taken against occupationally acquired injuries but they are not completely controllable. Thus, protocols have been put in place, stating the steps to take if such a situation arises. Wood (1995) found that 78% of practices where DSAs were employed had such a policy in place. Similar high figures appeared in the study of Corbin et al. (1988) in which 77% of dental schools had a post-exposure protocol. However, these particular findings must be treated with caution as the questionnaire was completed by the dean of each dental school and social desirability could have biased the results. Other protocols exist within this field to offer advice to dental team members not only about post-exposure prophylaxis and follow-up but also about clinical waste disposal and blood spillage. Ogden et al. (1997) indicated the lack of knowledge of the dental students surveyed of whom only 5% were familiar with the clinical waste disposal protocol. The extent of their ignorance was highlighted by the fact that only one in ten students were aware of the protocol for dealing with blood spillage on clinical surfaces. These are key areas of infection control without which the process would break down.

From the seventy-one studies reviewed, a great deal of useful information has been extracted. The literature available has dealt with numerous measures of infection control and offers both positive and negative findings. With the identification of existing problems, a step has been taken in the reassessment of dental infection control and offers health policy makers much food for thought. In particular, the formation and implementation of protocols tends to be overlooked by the dental team, as does the disinfection of impressions, the correct disposal of clinical waste and sharps and the follow-up to occupationally acquired injuries and hepatitis B vaccination and it is these areas which require attention. If changes are to be seen, knowledge of infection control will need to be improved as this forms the basis of both attitudes and behaviour. Compulsory educational courses may be of benefit, as the evidence suggests, but the implementation of such a directive may be problematic. Researching of the key indicators of those practices which comply with infection control guidelines could offer a means of identifying those practices which fail to meet standards. By developing a 'checklist' of infection control procedures which are only carried out by conscientious practices, inspectors could pinpoint more easily those failing to work according to the recommendations.

This world-wide review has integrated much literature, differing by objective, participant group, setting and outcome measures. The inconsistency of the findings has caused problems in the synthesis of the data and has not been helped by the perceived poor methodological quality of many papers reviewed. Investigation in the field of infection control can be challenging and interventions may have their practical difficulties in terms

of implementation but, arguably, no more so than other research areas whose standard of research appears much more rigorous. The availability of only one intervention in this area to promote guideline adherence cannot offer a remedy to the situation. Considerable improvements need to be made in terms of the quality of the research in this area and the means of assessing compliance with guidelines if more explicit and reliable answers are to be found to the many questions being posed. Furthermore, a reduced interest in this important area may be indicated by the fact that the majority of the data was collected over five years ago. Although many of the studies have been published in recent years, the research was, in many cases, carried out several years previously and only published in the light of intense media speculation. This points to an urgent need for a properly structured contemporary examination of dental practice infection control world-wide, using optimum methodology.

Cochrane Review

The aim of the present review was to determine the effectiveness of interventions to improve the dental team's adherence to infection control guidelines. A preliminary review of the literature revealed a less than adequate rate of adherence to published guidelines and the primary objective was to ascertain whether any interventions which had been carried out could provide a means of improving these worrying findings.

Within the field of dental related research, the searching of electronic databases for both published and unpublished trials, correspondence with experts and the scanning of references uncovered an encouraging number of studies related to infection control. Many of these studies again focused on the biological testing of infection control measures which are presently in place and others offered summaries of related topics rather than being experimental in nature and were therefore excluded. Furthermore, few studies exist which have attempted to intervene and manipulate the situation in order to test the possibility of improving a less than acceptable rate of compliance with regard to cross-infection control. As this review stipulates the inclusion of RCTs, CCTs, CBAs and ITSs only, the potential group of studies was reduced dramatically.

Following study evaluation, Gerbert et al. (1988) produced the single controlled trial retrieved from searches from 1980 to present. Despite the fact that this trial fulfilled the pre-specified criteria, in terms of design and methodology as well as the additional criteria specifically developed for this review, the study had to be excluded as it failed to assess key outcome measures. Its quality was most certainly compromised for a number

of other reasons. The highly selected sample of participants introduced bias as did the fact that only a very small proportion of dentists from the San Francisco area were represented. As a result, the findings of this trial, favouring the intervention, cannot be generalised to other settings or wider populations. These results were limited in their use as they simply indicated the efficacy of this particular intervention in an optimal setting and acted as recommendation for incorporation of such an intervention into a pragmatic trial if more reliable and generalisable results are to be found.

This field instead is dominated by surveys which employ self-report questionnaires. The nature of this study design introduces possible selection bias and the inherent problems of response rates. Furthermore, the standard method of measurement is fraught with potential biases as self-reporting of attitudes and behaviour can lead to an overestimation of socially desired responses. Attempts have to be made to ensure that non-respondent data does not differ significantly from respondent results. The limited observational data available encounter the same problems in terms of poor design, susceptibility to biases and lack of objective measurement. A subjective element can often encroach upon the recording of the data, despite attempts to create a scale by which behaviour can be measured. The presence of an observer can itself modify the behaviour of the subject and produce a false result. These study elements immediately exclude them from inclusion in a Cochrane review. This indicates the limitations in this essential research field arising from the problems of assessment.

In defence of the research to date, investigation in the field of infection control can be difficult and interventions may have their practical difficulties in terms of implementation but, arguably, no more so than other research areas whose standard of research appears much more rigorous. The means of uncovering the actual knowledge, attitudes and practising behaviour of dental team members is particularly problematic as social desirability will often compromise the findings. An objective measurement of these outcomes is extremely difficult. One solution may be to set a spontaneous examination for participants which poses questions pertaining to infection control. From the results, one could estimate the knowledge of the dental team member. Yet, willingness to participate could prove to be a stumbling block. The outcome measures under consideration here are fairly untenable entities. One might say that practising behaviour can be observed but even the presence of an observer has its modifying effects while use of a video camera has ethical and practical implications.

The poor quality of experimental design applied in this field is evident and is a problem which needs to be addressed. The present data available hold little weight in a Cochrane context and offer only limited answers to the questions being asked. The efficacy of infection control guidelines and reasons for non-compliance can only be estimated by the data produced by such studies. Reliable information is required if governing bodies are to make changes to improve the likelihood of compliance. Furthermore, the availability of only one intervention in this area to promote guidelines adherence can not offer a remedy to the situation. Considerable improvements need to be made in terms of the quality of the research in this area if answers are to be found to the many questions being posed.

CHAPTER VI

CONCLUSIONS AND FUTURE IMPLICATIONS

Implications for practice

- Despite the fact that a high proportion of dentists is in favour of barrier measures, the studies included in this review suggest that the overall rate of adherence to infection control guidelines in the dental profession is less than adequate and needs to be improved. A less than adequate level of compliance is defined in this review as less than 100% compliance.

- Several measures, such as hepatitis B vaccine acceptance and the sterilisation of hand instruments, are indicative of an increase in compliance with guidelines, but these successes are far outweighed by shortcomings. In particular, post-exposure follow-up, vaccination follow-up and impression disinfection are measures which tend to be overlooked by the dental team and require attention.

- Handpiece sterilisation continues to prove problematic for many dentists due to the cost of handpieces. The limited number of handpieces available makes sterilisation impractical and exposes the handpiece to added wear and tear. Government subsidisation may therefore help to rectify this situation.

- Current guidelines are explicit and widely available to the dental team but the policing of their implementation could be improved. By setting up an independent body to deal with practice inspections, the rate of guideline compliance could be increased.

- The level of occupational health support could be improved in practices in relation to hepatitis B vaccination follow-up and follow-up occupational injuries, both of which have been highlighted as key problem areas.

- The role of the dental surgery assistant is central to infection control. However, the rate of adherence within this particular group is inadequate and requires attention. An equalising of standard training and certification, on a global scale, may rectify this situation.

- A number of studies have highlighted orthodontists as being less compliant with regard to infection control than GDPs. The nature of their specialty offers some reasons for this poorer rate of adherence, but moves must be made to bring their behaviour into line with other dentists.

- Dentists' general level of knowledge appears to be inadequate as they have particular difficulties with modes of transmission of viral diseases, the risk of infection from a needlestick injury and awareness that measures against HBV are sufficient to protect against HIV. Compulsory educational courses may be of benefit.

Implications for research

- New methodological techniques need to be introduced for the assessment of the dental team's compliance with infection control guidelines as the present standard of study design is not suitably robust to produce reliable findings. Inclusion of a greater observational element within study design may help to reduce the socially desired responses resulting from the questionnaire-based and interview survey data currently available.

- Gaps are evident in the dental team's knowledge of infectious diseases and cross-infection control. Interventions aimed at improving their knowledge may lead to a change in the attitudes and, ultimately, the behaviour of the team.

- Researching of the key indicators of guideline adherence would enable a checklist to be developed and to be used by independent practice inspectors to pinpoint non-compliant practices.

- No studies were found from the extensive searches regarding the effect, if any, of surgery design on adherence to infection control measures.This is a possibility for future research

Cochrane Review

Implications for practice

- The studies which were potentially eligible for this review suggest that the overall rate of adherence to infection control guidelines in the dental profession is less than adequate and needs to be improved.

Implications for research

- The limited data set and poor quality of studies make it difficult to say for certain that the evidence pointing towards a generally unacceptable rate of guideline adherence is a fair representation of actual behaviour.

- This problem needs to be addressed and the methodology of future studies made more rigorous, in the hope of offering more reliable results from which conclusions can be drawn. Reliably designed and conducted interventions may highlight a means of improving the apparent inadequate rates of compliance.

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APPENDICES

APPENDIX I

Checklist	Study Element	Description	Appropriate Grading	Comments
1	Details of Pub.	Author		
		Title		
		Journal		
		Institutional Affiliation		
2	Research Question	Aim		
		Outcome		
3	Intervention	Focus of intervention		
		Name of programme		
		Number of conditions		
		Content of intervention		
		Theoretical model		
		Intervention site		
		Duration		
		Mode of delivery		
		Programme type		
		Any mediating variables investigated		
		Primary staff		
4	Study Design	RCT, cohort etc.		
		Unit of allocation		
		Method of randomisation		
5	Subjects	Target population		
		Inclusion criteria		
		Exclusion criteria		
		Recruitment procedures		
		Characteristics e.g. sex, age, ethnicity, SES, geographical location, other		
		Sample rep of study pop		
		No. subjects in each condition		
		Intervention and controls comparable		
6	Evaluation	Measure at baseline		
		What was measured after intervention?		
		Who carried out measurement?		
		Measurement tool		
		Were tools validated and how?		
		How was validity of self reported behaviour maximised?		

		Time interval between first and second measurement		
		Time interval between first and last measurement		
7	Analysis	Stat techniques used		
		Does technique adjust for confounding		
		Unit of analysis		
		Attrition rate		
		Attrition adequately each with		
		No. / % followed-up from each condition		
		Quantitative results e.g. estimate of effect sizes		
	Evaluation	Effect of intervention n mediating variables		
		Qualitative results		
		Cost of intervention		
		Cost effectiveness		
		Effectiveness of intervention (author)		
		Effectiveness of intervention (reviewer)		
		Agreement?		
8	Quality of study	Replicability of study		
		Design of evaluation		
		Programme content		
		Methods of implementation		
		Evidence of mediation variables		
		Specific reservations		
		Internal validity		
		Role of chance/confounding/bias		
		Generalisability of findings		
9	Reviewer's decision	Paper to be included?		

APPENDIX II

Checklist Point	Study Element	Description	Appropriate Grading/ Comments
1	***Study design***		
1A	**What study design is used ?**	RCT, CCT, CBA or ITS	
1B	**CBAs - 2 minimum criteria**	**1.** Pre/post intervention periods same for study and control sites **D/NC/ND**	
		2. Control and study sites comparable. **D/NC/ND**	
1C	**ITSs - 2 minimum criteria**	**1.** Clearly defined point in time for intervention **D/NC/ND**	
		2. At least 3 data points pre and 3 post intervention. **D/NC/ND**	
2	***Methodological inclusion criteria - for all study designs!***	**1.** Objective measurement of performance in clinical not test situation **D/NC/ND**	
		2. Relevant data interpretable and obtainable **D/NC/ND**	
3	***Intervention***	State all interventions for each study group. e.g. professional, financial, provider-orientated, patient -orientated etc.	
4	***Controls***	**1.** No intervention control group/ standard control/ untargeted activity /other	
	Type of targeted behaviour	**2.** Clinical prevention services/diagnosis/ test ordering/ referrals/procedures/prescribing/ management of problem e.g. high bp	
5	***Participating Providers***	Profession - physicians/dentists/mixed/other	
5A	**Level of Training**	Training/licensed/mixed/other	
5B	**Clinical speciality**	Surgery/radiology etc.	
5C	**Age**	Mean age	
5D	**Graduation**	Time since graduation	
6	***Participating Patients***		
6A	**Characteristics of subjects**	State area that intervention targets e.g. hypertension	
6B	**Other characteristics**	Age, gender, ethnicity, other.	
6C	**No. of patients who entered study**		
7	***Setting***		
7A	**Reimbursement system**	Fee for service/capitation/prospective payment/ global budget/mixed, **NC**	
7B	**Location of care**	Inpatient, outpatient, community based,	

		mixed, other	
7C	**Academic status**	University based teaching setting, mixed, **NC**	
7D	**Country**		
7E	**Proportion of eligible providers**	State % provides in target pop. allocated to study groups	
8	***Methods***		
8A	**Unit of allocation**	Who or what was allocated to study groups-patient, practice, clinic day etc?	
8B	**Unit of analysis**	Results analysed as events per practice etc.	
8C	**Power calculation**	Sufficient statistical power to detect sig. clinical effects? **D/NC/ND**	
9	***Quality criteria for RCTs and CCTs***		
9A	**Concealment of allocation (protection against selection bias)**	Score **D** if random process described, **ND** if report using record nos., DOBs. **D/NC/ND**	
9B	**Follow-up of professionals (protection against exclusion bias)**	Score **D** if outcome measures obtained for 80% or >of Ss randomised, **ND** if <80% **D/NC/ND**	
9C	**Follow-up of patients or episodes of care**	Score **D** if outcome measures for 80%> Ss randomised or patients entered trial or if objective collection system. **D/NC/ND**	
9D	**Blinded assessment of primary outcomes (protection against detection bias)**	Score **D** if outcomes explicitly state blindness or if outcome variables objective e.g. length of hospital stay.	
9E	**Baseline measurement**	Score **D** if patient outcomes measured prior to intervention + no substantial diffs across groups. **D/NC/ND**	
9F	**Reliable primary outcome measures**	Score **D** if 2or>raters 90%agreement or outcomed rom aotomated system, **ND**<90%. **D/NC/ND**	
9G	**Protection against contamination**	Score **D** if allocation by community, institution practice+unlikely **controls** received intervention **D/NC/ND**	
10	***Standard criteria for CBAs***		
10A	**Baseline measurement**	Score **D** if patient outcomes measured prior to intervention + no substantial diffs across groups. **D/NC/ND**	
10B	**Characteristics for studies using second site as control**	Score **D** if characteristics for study and control provides reported +similar **D/NC/ND**	

10C	**Blinded assessment of primary outcomes**	Score **D** if outcomes explicitly state blindness or if outcome variables objective eg. length of hospital stay. **D/NC/ND**	
10D	**Protection against contamination**	Score **D** if allocation by community, institution practice+unlikely **controls** received intervention **D/NC/ND**	
10E	**Reliable primary outcome measures**	Score **D** if 2or>raters 90%agreement or outcomed rom aotomated system, **ND**<90%. **D/NC/ND**	
10F	**Follow up of professionals**	Score **D** if outcome measures obtained for 80% or >of Ss randomised, **ND** if <80% **D/NC/ND**	
10G	**Follow up of patients**	Score **D** if outcome measures obtained for 80-100% subjects allocated or entered. **D/NC/ND**	
11	***Standard criteria for ITSs***		
11A	**Protection against secular changes**	**D/NC/ND**	
11B	**Protection against detection bias**	Score **D** if reported intervention unlikely to affect data collection e.g. methods of collection same B+A. **D/NC/ND**	
11C	**Blinded assessment of primary outcome**	Score **D** if outcomes explicitly state blindness or if outcome variables objective e.g. length of hospital stay. **D/NC/ND**	
11C	**Completeness of data set**	Score **D** if data covers 80-100%total no. of Ss **D/NC/ND**	
11D	**Reliable primary outcome measure**	Score **D** if 2or>raters 90% agreement or outcomed rom aotomated system, **ND** <90%. **D/NC/ND**	
12	***Consumer involvement***	Consumers involved in design, conduct or interpretation of study **D/NC/ND**	
13	***Barriers to change***	Identification of some barriers in target pop. addressed by intervention. e.g. clinical uncertainty, sense of competence financial disincentives.	
14	***Intervention***		
14A	**Evidence base of recommendation**	If based on good evidence - **D/NC/ND**	
14B	**Purpose of recommendations**	Approp management, cost containment, other, **NC**	
14C	**Nature of desired change**	Initiate, stop introduction, reduce, increase, cessation, modification of new/established management	
14D	**Format**	Type of medium employed for each intervention e.g. computer, multimedia, audio etc.	
14E	**Source**		

14F	**Intervention based on implementation of clinical practice guidelines**	**D/NC/ND**	
14G	**Guidelines developed through formal consensus process**	**D/NC/ND**	
14H	**Recipient**	State if each intervention delivered to individual, group, **NC**, other?	
14I	**Deliverer**	State who delivered intervention.	
14J	**Timing**	Proximity, to clinical decision, frequency of intervention, duration of events.	
14K	**Setting of intervention**	Practice/non practice, **NC**	
14L	**Source of funding**		
14M	**Ethical approval**	**D/NC/ND**	
15	***Outcomes***		
15A	**Report all main outcomes**		
15B	**Cost of intervention**	Changes in direct health care or non health care costs associated with intervention	
15C	**Length of time outcomes measured after initiation of intervention**		
	Length of post intervention follow up		
15D	**Identify possible ceiling effect**	Little room for improvement	
16	***Results***		
16A	**For RCTs + CCTs**	State main results for each group, each comparison report baseline and post intervention diffs between study + controls.	
16B	**For CBAs**	State baseline and post intervention results for each study group. Calculate pre/post intervention diffs for each outcome. Each comparison diffs across study groups of pre/post intervention change.	
16C	**For ITSs**	State main results for each group.	

KEY

D = DONE
NC = NOT CLEAR
ND = NOT DONE

APPENDIX III **Characteristics of Included Studies**

STUDY	METHODS	PARTICIPANTS	OUTCOME MEASURES	GUIDELINES	MAIN FINDINGS	NOTES
Gerbert et al. 1988	Questionnaire adapted and revised. Information collected at baseline and again 6 months later.	Volunteer based sample of dentists identified by invitation of all licensed, practising dentists in the San Francisco area to participate.	Intervention: Educational intervention with three components over a 6 month period. Information bulletin pack, feedback from pretest score and conference call.	No specific guidelines stated.	Knowledge of HIV/AIDS and infection control practice scores significantly higher for experimental group. This finding held true for all five variables measured. Control scores had improved nevertheless. No indication was given as to the component of the intervention producing the effect or if the intervention would be effective for other sample populations.	Highly selected sample. Dependent variables not objectively measured. Outcome assessment not described as blind.
Burke et al. 1992	Survey Self administered questionnaire	GDPs in England and Wales practising within NHS Regulations. Random Sample. 1530/2000 = 80% responded.	Glove wearing Mask wearing Attendance at postgraduate courses.	CDC Recommendations 1986 Council on Dental Materials etc. 1988	**Relationship:** Gender/glove use = S, $p<0.00028$. Location/glove use = S, $p<0.0045$. Size of practice/glove use = S, $p<0.00092$. Distance/glove use = S, $p<0.02043$. Course attendance/glove use = S (?) Location/mask use = NS, $p<0.05$. Size of practice/mask use = NS. Willingness to treat/mask use = NS Willingness to treat/glove use = S(?)	

Burke et al. 1992	Survey Self administered questionnaire	GDPs in England and Wales practising within NHS Regulations. Random Sample. 1530/2000 = 80% responded.	Glove wearing Mask wearing Attendance at postgraduate courses.	CDC Recommendations 1986 Council on Dental Materials etc. 1988	Analysed results from a subset of 41 orthodontists. More than one third wore glove routinely, 49% for selected patients, 12%never wore gloves. Only 6% of routine glove wearers changed them between patients. Reasons for not wearing gloves: loss of sensation, cost, dexterity, perceived risk of. Only 22% in this sample wore gloves routinely and 37% wore them for selected patients or procedures only.
Katz et al. 1989	Survey Self administered questionnaire	Directors of dental radiology departments of all US and Canadian dental schools. 62/69 participated.	IC control Existence of protocols	Council on Dental Materials etc. 1988 CDC Recommendations 1986, 87. ADA Recommendations 1982, 85, 88.	94% had infection control policy in place. 34% had additional protocol for high risk patients. Students of all 62 schools wore gloves developing intraoral radiographs. Other items used less.
Corbin et al. 1988	Survey Self administered questionnaire	Deans f US dental schools 47/55 replied.	Knowledge, attitudes about HIV. IC education Existence of protocols for IC	ADA 1978 CDC 1985, 86 MMWR 1987 ADA 1985, 87, 88 CDC 1986	All 47 schools offered classroom instruction and majority offered clinical instruction. 51% had protocol for high risk patients, 66% had policy for waste disposal, 87% had needles and sharps' policy, 77% had needlestick injury protocol. In 1982, 13% wore gloves routinely. 15% masks and 50% eyewear. In 1986, 81% wore gloves routinely, 72% masks and 81% eyewear.

Pitts & Nuttall 1988	Survey Self administered questionnaire	Community dentists and GDPs in Scotland. All those registered with GDS and CDS. 1178 = 72% response.	Protective measures adopted Care of HIV patients. Willingness to treat.	BDA Guidelines 1987	A third of dentists used gloves routinely, 79% for invasive procedures. Mask and eyewear use considerably less. 58% sterilised instruments using autoclave, 44% used dry heat and the remainder used cold. 80% of dentists and their DSAs had been vaccinated against HB. Differed for GDS and CDS dentists.	
Mitchell & Russell 1989	Survey Self administered questionnaire Follow-up 5 years 1983-88.	Scottish Lothian and Borders Region dentists. 168/238 = 70.6% response.	Glove use Main objections Behaviour and opinion of dentists regarding IC.	No clear guidelines stated.	77 (46%) wear gloves for all procedures. 21 (12.5%) wear them treating potentially infectious patients only. 5 (3%) did not wear gloves. 86% had objections about use of gloves. 58 (67%) loss sensation, 11 (13%) cost, 8 (9%) patient reaction. Min advantages of wearing them prevention of CI 141 (84%), prevention of dermatitis 5 (3%), relief of patient anxieties 16 (9.5%), self protection 4 (2.5%), no advantage 2 (1%). 48 (29.5%) used hot air oven and cold sterilisation. 44 (26%) used autoclave, 42 (25%) use hot air oven only.	Check preliminary study.

Blair & Wassell 1996	Survey Self administered questionnaire	All UK dental hospitals. Heads of conservation and prosthetic departments. 100% response.	Types of impression material used, methods of disinfection and adverse reactions.	BDA 1987 ADA 1988	All UK dental hospitals rinsed impressions with water. All departments except 5 then disinfected them. 60% of departments failed immersion times. Adverse reactions to solutions noted.
Porter et al. 1995	Observational study	Staff, students at emergency oral medicine clinic in a DH. 79 dentists, 35 students.	215 patients encounters videotaped. Handwashing before and after contact. Clove use. Mask use. Eye protection	CDC various	Treatment Contacts DEN/STU Handwashing 13% v 70% Glove use: 81% v 100% Mask use 56% v 23% PPE 42% v 27% Change gloves between patients 63% v 60% Neither changed nor washed 11% v 3%
Scully et al. 1991	Survey Self administered questionnaire	Clinical dental students in final 2 years. University of Amman, Jordan. 99% response (n=120).	Perceptions of infective risk from various viruses acceptance of Hep B vacc. IC measures adopted.	No guidelines	Half of respondents had been vaccinated against hepatitis B. Only 4% of those who had not were considering vaccination. 82% reported sterilising instruments by autoclave, although 11% failed to respond to the question.
Hudson-Davies et al. 1995	Survey Self administered questionnaire	NW England dentists 917/1229=75% GDPs	Knowledge of IC. Opinion of guidelines need for information. How to keep up to date.	BDA guidelines 1988	92% knew IC measures for HBV sufficient for HIV. Younger dentists know more about CI ($p<0.05$). 83% dentists favoured dental journals to keep up to date. 70% felt guidelines imp and feasible. Knowledge and opinion scores showed positive correlation ($p<0.001$)

Bentley & Sarll 1995	Survey Self administered questionnaire 2 times follow up 'Panorama'	NW England dentists. 5 authorities selected. 312/422 = 74%.	Adoption of CI 1990 and 1993. Introduction of equipment since 1990. Influential factors of change. Media questions.	Preliminary BDA guidelines - not stated.	Dentists/ DSAs Gloves use 86% v 80% PPE 68% v 48% Heavy duty gloves DSAs 31% Autoclave handpieces 77% BDA guidelines 70%, media 50%.
Ashton et al. 1994	Survey Interview	NW Health Region English DSAs 82/107 = 77% response.	Some of info on IC. Reasons not IC. Opinion on help and advice given about IC. Association between worry and support given.	Health & Safety At Work Regulations 1992 BDA Teamwork Initiatives 1991 BDA Advice Sheet A12 1991	Sources of info. dentists 56 (68%), leaflets 54 (66%), dental companies 25 (30%). Opinion on help and advice 15 (18%) v. good, 36 (44%) good, 22 (27%) acceptable. Reasons for NOT CI time 26 (74%), facilities 5 (14%), lack of info. 2 (6%).
Angelillo et al. 1994	Survey Self administered questionnaire	Italian dentists Random sample. Italian Dental & Maxillofacial Association. 1000 selected = 73%	Demographics. Practice characteristics. Attitudes towards AIDS. Knowledge about AIDS. IC procedures.	CDC 1989, 1990.	Respondents overestimated visits of infected by HIV. 22.1% buried HIV could be transmitted by saliva. Knowledge sig. higher with more contact with HIV+ patients. Fear of infection understandable for 82.9%. 55% felt HIV+ care should be given in specialised centre. 31% felt refusing treatment of HIV= understandable. 68.2% correctly thought measures for HBV sufficient for HIV.

Cohen et al. 1997	Survey Self administered questionnaire	Random sample US endodontists and some serving in the military abroad. 422/750 = 56.3% from pool of 2603.	Demographics. Hep B vacc. Willingness to treat.	CDC 1984, 1987 Others but not guidelines.	95% HB vaccinated. 82% offices reporting all personnel vaccinated against HBV. 99% wear gloves during contact, 95% for whole procedure. Protection against diseases by IC measures: 95% herpes, 94% HBV, 93% HIV. Willing to treat 95% HBV, 93% HIV, 92% Herpes, 82% TB. 25% felt medical histories accurate.
Bray & Chapman 1990	Survey Self administered questionnaire	Random sample. Australian Dental Association membership. Practising. 1130/1410 = 80%. Only 1/3 total.	Attitudes to treating, retrieving HIV patients. Knowledge of symptoms. Reception of personal risk. IC procedures. Demographics. Information sources.	ADA News Bulletin 1986, 1987, 1988. AIDS Task Force 1986 - Australian Government Publishing Service.	2/3 treated known or suspected HIV+ patients. Post 1980 45.5% had, pre 1960 24.6% had ($x2= 24.27$, $p<0.001$). 83% willing to treat. 78% prefer to refer to specialised centre. 86% low to moderate risk, 6% high risk. 48% incorrectly suggested saliva route of transmission. 84% HB vaccinated. 65% routinely wore gloves, 68% masks, 12% sterilise and 87% disinfect handpieces.

Soto et al. 1993	Survey Self administered questionnaire	Random sample. Registered member of Quebec dental professional corporate. 342/2956 members 65.8% responded.	Demographics. IC practices Attitudes, beliefs and knowledge about AIDS.	ADA Council on Dental Materials 1988 CDC 1986 CDA 1988	Only 8.5% treated HIV+ patients, 37.5% had treated high risk patients. Overestimation of risk. Low knowledge scores associated with years in of practice. OR= 2.3 (CI=1.22-4.23) and high risk perception (OR=1.8, CI=1.06-3.21). Glove use 50.5% for all procedures. New pair for each patient 63.8%. 65.5% wore masks, 77.3% wore eyewear. Disinfect surfaces after each 70.2%. 82.7% sterilised instruments.

Ogden et al. 1997	Observational study Questionnaire	Clinical dental students at Dundee DH. 3rd n=120. 4th n=120 5th n=40. 100% response.	Q- postexposure and IC practices. R- Ob- IC precautions before, during and after observed. Purpose unknown to Subject.	BDA A12 1991, 1996	Q- 2/3 3rd and 4th, ½ 5th incorrectly reported protocol for post exposure. Gloves, masks, eyewear essential for conservation - PPE for extraction. Students believed DSAs needed protection. 1/10 could give protocol for blood spillage on clinical surfaces. Less than 5% correctly stated protocol for disposal of clinical waste. 2% (3+4) 5% (5) did not wash hands before putting gloves on. Gloves always worn, masks less, PPE less. Cleaning of bracket table and decontamination of 3in1 in nearly all cases.
Lange et al. 1996	Survey Self administered questionnaire	Brisbane region dentists. Random selection. 250/493 total. 210 (80.4%) responded. 25 random non repliers phoned. Telephone directory.	PPE Demographics	FDI Policy 1993 Queensland State Government 1992 National Health and MRC 1987, 1992. Australian National Council on AIDS 1990 Worksafe Australia 1992, 1993. CDC 1986, 1988.	Gloves worn routinely 170 (84.6%) Never worn 3 (1.5%). But all wore other items. Divided into 5 groups. 1-16 (9.4%) only changed gloves when stained. Variability within groups. 1) Routine 2) Selected patients only 3) Selected procedures only 4) Selected patients and procedures 5) Never.

Gershon et al 1998	Survey Self administered questionnaire	Random sample. Maryland State Department of Health Board of Dental Examiners practising 392/648 = 60% response.	IC practices individual factors psychosocial factors Organisational factors Compliance.	ADA Council o Dental 1988 ADA Council on Dental Therapeutics and Council on Prosthetic Services and Dental Lab Relations 1985 OSHA 1991 CDC 1985,86,87,88,89,93	Knowledge scores generally high 44% incorrectly reported saliva as possible route of transmission. 28% have high fear of contagion. 10% unwilling to treat known HIV. 56% right to refuse. 69% tolerant and accepting. 98% believe IC protects. 28% reported parenteral or muscocutaneous exposure to blood/saliva. 7% had needlestick in last 6 months. 3% had follow up. 36% always complied with 12 IC measures. 90% had safety program. Conflicting results. 84% HB vaccine. High level of compliance and tolerant attitudes ($p<0.05$), high belief in IC ($p<0.05$), high knowledge scores ($p<0.05$), history of exposure ($p<0.05$).
Treasure & Treasure 1997	Survey Self administered questionnaire Further info interview. Unstructured discussion 3 final year trained	New Zealand dentists. From corporation mailing list. 1076 practices, 767 useable 71.3% response.	Clinical waste disposal sharps disposable items.	No real guidelines stated	78.9% cotton rolls in paper bin. 80.25% put sharps in special containers. 73.3% made special arrangements for disposal. Auckland practices (handling waste sig. difference from overall. Only 13.7% Auckland disposed of sharps in general household rubbish v 24.4%. 75.8% (Auckland) v 44.7% used specialised firm. ($p<0.001$).

Treasure & Treasure 1994	Survey Self administered questionnaire	New Zealand dentists. Corporate mailing list773/1076 = 71.8% response	Waste disposal IC measures	No real guidelines stated.	81% of dentists felt info in journals useful. 1% felt it was irrelevant. 25% said no high risk patient had sought treatment. 26% would refer high risk patient to a clinic. 41% would treat anyone. Different methods of sterilisation were used. 92% used autoclaves, 15% dry heat. 95% wore gloves routinely which was higher than 43% recorded in 1988.
Waddell 1997	Survey Self administered questionnaire	Dentists and hygienists in WA Registered with WA branches of ADA and Dental Therapy Association of WA. N=208 (63%) Dentists n=550 (76%) hygienists.	Demographics Perceived risk of contracting infection while performing 11 procedures. Opinions on treatment for HIV. Need for HIV testing on all DHCWs.	N/S HIV and IC survey FDI World Health Congress 1990.	Divided into low and high risk categories. High risk less likely invasive on HIV+ and more likely on to terminate if they find oral manifestation , more likely to agree to testing, more likely to abstain from ?? Sig. difference in perceived risk of contracting HIV hygienists (mean 36.7) and dentists (mean 44.1) ($t=4.12$, $p<0.001$).
McCarthy & MacDonald 1999	Questionnaire based survey.	Subjects recruited from list of GDPs from the Royal College of Dental Surgeons of Ontario in 1993. 70% response achieved from potential sample of 5176 GDPs.	Measured the frequency of infection control practices and factors associated with their use. Demographics, GDPs' knowledge of infection control and their attitudes relating to treatment of high risk patients.	CDA recommendations 1988, 1992. OSHA 1991. CDC 1996.	92% of dentists and 61% of clinical staff vaccinated against hepatitis B. 92% wore gloves routinely, 75% wore masks and 84% heat-treated their handpieces. More than half of respondents were concerned about the costs of infection control.

McCarthy et al. 1996	Survey Self administered questionnaire	Ontario dentists. Health Planning Regions, Health Council list. 5997 = 70.3% response.	Demographics Willingness to treat Opinion of AIDS Knowledge about AIDS IC precautions	CDA Recommendations 1992	Age and population of town where practice located sig. associated with willingness to treat. Age and continuing education sig. associated with willingness.	Detailed results.
Razak et al. 1991	Survey Self administered questionnaire	Malaysia dentists . Dentist Register of Malaysia 1987. 727/1217 = 61.1% response.	Awareness of HB vaccine. Acceptance and rationale for not doing so. Perceived degree of risk of infection. Glove use. Needlestick injuries.	CDC Statement 1983. BDA Dental Health and Science Committee Workshop 1986.	44.8% vaccinated. 9.9% dubious of effectiveness. Other reasons: fear of side effects, fear of contracting AIDS, cost etc. High risk 22.4% for acceptors, 23.1% for non. Routine glove use acceptors 28.3%, 21.5% for non. Never wear gloves 9% for acceptors, 22.3% for non. Needlestick injuries (1-5) 57% for acceptors, 56.2% for NON.	
Manz et al. 1994	Survey Self administered questionnaire . 1988 and 1991 surveys compared.	VA dentists (553/885 = 62.5%) DSAs and hygienists (132/156 = 84.6%.	IC precautions HIV continuing education Attitudes of treatment of HIV+ patients.	CDC Recommendations 1985, 86, 87, 89. ADA Council on Dental Material Recommendations 1988.	1988/1991 results Attended 1 or > courses Dentists 83.5%/96.9% Hygienists 88.2%/97.7% Injuries Dentists 23.9%/29.6% Hygienists 20.3%/14.4% Dentists 35.8%/61.3% Hygienists 51.3%/68.9% Source of info. about AIDS Courses 31.3% (D) 34.1% (H) Source of info. about IC Policy guidelines 27.3% (D) Courses 28.8% (H)	

Verrusio et al 1989	Survey Self administered questionnaire comparison of 1986 and 1988 surveys.	Random sample of US dentists. Private practice. File containing US dentists. 3 mailings 5711 = 58%. Sample of non-responders telephoned	Demographics Hep B vaccination Health histories Continuing education IC precautions Attitudes about AIDS	Council on Dental Materials etc. 1988 Department of Labour… advisory notice 1987.	1986/1988 Use of gloves (Always) 23%/76% (GDPs) 32%/91% (specialists) Masks 26%/47% Eyewear 71%/82% Gowns 13%/20% Freq. of Needlestick 0.6/0.22 per month Willingness to treat AIDS 21%/31% Hepatitis 64%/73% Herpes 79%/85% etc.
DiAngelis et al. 1989	Survey Self administered questionnaire Follow up using 45 % of original sample.	All licensed Minnesota dentists 1986- 1623 (59%) 1987- 827 (61%)	Demographics Hep B vaccination Injuries IC practices Education Opinions on DSAs and hygienists	CDC Recommendations 1986 ADA Council n Dental Materials etc. 1988	Demographically comparable 2 samples. Increase in IC precautions 1986-1987. Also for HB vaccine. Compliance higher for those with fewer years in practice.
Bednarsh & Connolly 1990	Survey Self administered questionnaire 1986 - 1988	15% random sample of Massachusetts licensed dentists. N=700, after second mailing 60% response.	IC precautions Needlestick injuries Treatment of infected patients.	CDC 1987 but not referenced.	Glove use 24%/81% routine Mask use 26%/51% Eyewear 79%/82% 1988 88% autoclave instruments 18% autoclave handpieces 45% amalgam carriers 2/3 felt hospital clinics better for HIV+ patients.

Chehaitly & Alary 1995	Survey Self administered questionnaire - multiple choice	Quebec third and fourth year dental students from 3 schools in province 188/307 = 61.2% response.	Demographics Knowledge and attitudes towards AIDS and Hep B. IC practices Perceived risk.	ADA Recommendations 1988 CDA 1988 CDC 1991	Overall knowledge good (slightly better for 4th years). Knowledge Hep. B better than HIV. Clinical knowledge poor for both groups. Score of risk perceptions sig. lower for HIV ($p<0.0001$). 92% believe dentists have responsibility to treat HIV+ patients. 57.4% believe they should be treated in specialised centre. Compliance with IC practices generally high. More than 80% for all procedures except handwashing (66%). All but one had HB vaccine.
Gore et al. 1994	Survey Self administered questionnaire	Scottish Lothian Region dentists. Lothian Health Board ad University staff lists. N=310 (70% responded).	Waste disposal Injuries	UK Health Departments 1991 BDA Advice Sheet A12 1991	12% had not completed HB course. 1981/1991 Routine glove wearing 7%/78% Never 56%/1% Routine mask wearing 34% Never 18% Routine eyewear 54%. 63% resheathed needles without a guard 79% sterilised handpieces. Freq. of injuries similar.

Hellgren 1994	Survey Self administered questionnaire . Follow up study	Southern Swedish Community and private dentists. 1988 public/private 167 (66%)/24 (63%) 1991 117(78%)/141 (71%).	Demographics IC practices Perceived risk	Mentions Swedish National Health Board guidelines but not referenced.	**1988** Gloves: routine wear 61% public, 4% private 77% felt risk of HBV small 76% felt risk of HIV small. Reasons for adopting gloves: 65% media, 26% scientific papers, 9% clinical joint decision. **1991** Risk of HIV low 78% Risk of HBV low 78%. Reasons for adopting gloves: 46% media, 17% others, 5% colleagues/lectures. 29% private dentists use for all, 61% for selected procedures. 76% public dentists use for all, 23% for selected.

Razak & Lind 1995	Survey Self administered questionnaire	Professionally trained Malaysian dentists. List in Malaysian Government Gazette 1990, those granted Annual Practising Certificates to practice in Malaysia in 1990. 972/1330 = 73.1% response.	IC measures - glove, mask, eyewear use. Injuries, disinfection, sterilisation of instruments and handpieces etc. Frequency of injuries.	No guidelines or recommendations mentioned or referenced.	54% routinely wore gloves. 13% never wore gloves. Male dentists and private practitioners less likely to wear gloves. 83% wore masks for all procedures - **more** males and private dentists wore these. Wearing of face mask sig. associated with seniority. 50% wore eyewear. 33% never.7% sterilised handpieces after each patient. 81.6 disinfected them instead. Seniority correlated with sterilisation of handpieces. 78% sterilised instruments after each patient. Only 0.6% neither disinfected or sterilised. More females and public dentists reported sterilising instruments. 31.1% had 1-3 needlestick injuries in the last month.

Burke et al. 1991	Survey Self administered questionnaire	English and Welsh NHS registered dentists. Working within NHS Regulations on 1989 list. 1530 (76.5%) returned and completed properly.	Glove use and related problems. Needlestick injuries.	Council on Dental Materials etc. 1988 BDA 1987 MMWR Recommendations 1986	59% attended up to 5 postgraduate courses in previous year. 18% more than that. 50% had treated high risk patients and were willing to do so in future. 685 wore gloves routinely and main reason for more than 0% to change them is an obvious tear. More than 70% of dentists who used gloves for selected patients only said loss of sensation reason for not wearing gloves. 30% always wore a mask, 13% sometimes, 12% never. 37% ad suffered needlestick in last year, 47% suffered laceration or dental instrument wound in that time.
Kaimenyi & Ndung'U 1994	Survey Self administered questionnaire	Dental auxiliaries (dental technologists dental technology final year students, dental hygienists) working at University of Nairobi. 65/71 = 91.5% responded.	Treatment of HIV patients. Knowledge and attitudes towards AIDS. Knowledge and behaviour in relation to IC.	**Only** Ministry of Health -AIDS control programme 1992.	66% knew only one or two lesions connected with AIDS out of a possible 7. 90.8% did not know time span within which someone can develop full blown AIDS.84.6% felt all patient should be treated as AIDS patients.40% believed chemicals and 16.9% felt boiling water were sufficient for sterilisation. 70.8% used gloves for treatment of AIDS patients, 58.5% o these changed them for each patient. 67.7% used masks routinely 43.1% used eyewear when treating AIDS patient.56.9% felt HIV+ should be treated in specialised centre.

McCarthy & MacDonald 1997	Survey Self administered questionnaire	Ontario dentists from the Royal College of Surgeons of Ontario 1993. 3552/5176 = 70.1% response.	Demographics IC measures HB vaccination Needlestick injury	CDC 1991 ADA 1996 CDA 1992	92% had received HB vaccine. Only 61% reported all clinical staff vaccinated. 62% reported routinely using PPE measures. 36% sterilised handpieces. Compliance with IC measures sig. predicted by female, age<40 years, practice location, lack of concern related to costs, HBV more infectious than HIV from logistic analysis. Analysis showed lack of knowledge that HBV measures sufficient for HIV, risk of contracting HIV from needlestick, age>39 years, concerns personal risk cost of IC measures and loss of patient indicated predictors for use of additional measures for HIV+ patients. Data also available for other factors

McCarthy & MacDonald 1997	Survey Self administered questionnaire	Ontario dentists from the Royal College of Surgeons of Ontario 1993. 5997 = 70.3% response.	Demographics Treatment of HIV+ patients Knowledge of HB vaccine and HIV IC practices Attitudes and beliefs.	No guidelines mentioned or referenced.	Male dentists is more likely to be specialists, older and to practice in smaller pop centres. Females sig. more likely to be younger, general dentists, practice in larger urban pops. Women were sig. more likely to have attended a course in the last 2 years. This association was not confounded by age, location or speciality. Women related sig. larger number of HIV+ patient ($P<0.01$). Men sig. more likely to correctly identify risk of contracting HIV from needlestick. Males sig. more likely to agree other patient may refuse to come if HIV patents treated there. More males agreed profession has responsibility to treat HIV persons - gender not sig. but age was. Women more likely to comply with IC practices, also more likely to take extra precautions for HIV+ patient, to wear gloves, change them, wear a mask, wear eyewear, be HB vaccinated. Gender effect confounded in many regressions.

Woo et al. 1992	Survey Self administered questionnaire	Californian orthodontists and general dental practitioners. Members of Pacific Coast Society of Orthodontists and American Dental Association respectively. 124/220 (61% for orthodontists) 126/500 (25% for GDPs)	Practice profile Perception of risk from HIV an HBV Exposure to blood Barrier protection used Sterilisation and disinfection procedures employed.	Council on Dental Therapeutics etc. 1985 CDC Recommendations 1986 Council on Dental Materials 1988 CDC, MMWR 1987	Orthos perceived less patients carrying HIV and HBV compared with GDPs. Orthos reported injuries once every 4 weeks compared to once every 10 weeks for GDPs. GDPs and their assistants wore barriers sig. more often than orthos an assistants ($p<0.005$). GDP/ORTHO:79/17 mask, 94/80 gloves, 92/63 eyewear. GDP ASSIS/ORTHO ASSIS: 72/17 mask, 91/89 gloves, 80/46 eyewear. 95% GDPS change gloves between patients, only 59% of orthos do so. Orthos reported sterilising instruments, pliers, handpieces less than GDPs. 78% orthos reported impressions not disinfected before going to lab. 74% for GDPs.

ter Horst et al. 1989	Survey Self administered questionnaire	All Amsterdam dentists. 470 = 625 response.	Compliance with infection control measures Perceived knowledge, fear. Behaviour related to IC Treatment of HIV+ patients.	Mentions Health Council guidelines but does not reference them.	95% wore gloves, almost all of which changed them between patients. 5% used for certain procedures. 84% wore masks, 90% wore eyewear. 25% of these did not wear them all the time. 54% had specialised container for used needles.89% used an autoclave but not properly. Compliance score calculated - 90% complied reasonably or better. Dentists older than 65 complied less well ($F=6.23$, $df=3,280$, $p<0.001$) No other associations. 95% had heard of guidelines. 87% felt adequately informed about AIDS. No relation between demographic variables and knowledge. >30% wanted more training. 40% felt necessary to know HIV status of patient. 30% expressed high fear of contracting HIV. Those less informed expressed more fear ($t=4.60$, $df=278$, $p<0.001$).
Foley 1994	Survey Self administered questionnaire 1988 and 1993 surveys compared.	Directors of dental hygiene programmes in US and Puerto Rico 1993. 178/211 = 84% response.	Clinical attire requirements - gowns, lab cots, masks, eyewear, shoes etc.	OSHA1989, 1991 MMWR 1986, 1988, 1993 ADA Council on Dental Materials etc. 1988 Journal specific guidelines also available.	Currently 46 programs use disposable gowns, 34 of these are located in South Atlantic, East North Central and West South Central regions. All students wore gloves, masks and eyewear. 46% programs had outer garments professionally laundered. **Results restricted.**

Matthews 1989	Survey Self administered questionnaire	Avon dentists from Avon Family Practitioner Committee. 200/297 = 69.7% response.	Attitudes to the treatment of known carriers of HBV or HIV Use of latex gloves Details of sterilisation methods employed.	BDA GUIDE 1987	59% would provide treatment with additional precautions for those with HBV and 45% for HIV. 42% would refer HBV carriers for hospital treatment and 56% for HIV carriers (n=198). 42% use glove s for all or most patients, 34% when likely to contact blood, 32% for high risk patients and 11% never wear them. 21% dentist believe patients dislike taste of gloves. 35% welcome them, 53% uncertain. 81% reported difficulty in manipulating small instruments as man reason. 63% believe BDA recommendations state gloves should be worn routinely. 78% use autoclave to sterilise instruments.

Matthews et al. 1986	Self-report questionnaire based survey.	All 357 dentists practising in Avon Are Health Authority were contacted. 218 responded (61% response).	Hepatitis B vaccination, side effects, reasons for accepting or not accepting the vaccine and use of gloves during patient contact.	No explicit guidelines referenced.	55 subjects had been vaccinated against hepatitis B with 15 undergoing the programme. This only represents 32% of responders. 148 subjects remained unvaccinated. 54% reported their intention to be vaccinated. Reasons for not being vaccinated included fear of infection via plasma derived vaccine, fear of consequences of a positive result, unaware of vaccine, fear of allergy and side effects, natural immunity. Only 20 out of 70 vaccinated had received follow-up testing. 12% had suffered mild side effects.

Hastreiter et al. 1992	Questionnaire- based survey. Extension of previous work to include dentists.	Subjects drawn from licensed dentists, licensed dental hygienists and registered dental assistants in Minnesota. Samples selected to achieve minimum 60% response rate. 695 of dentists, 73% of dental hygienists and 56% of dental assistants responded.	Demographics Practice profile HB immunisation treatment of infectious patients Use of barrier techniques Needlesick injuries Waste disposal Knowledge of AIDS	CDC recommendations 1996.	62% of the total sample had attended an educational course relating to infection control. 57% reported being knowledgeable or 'very' knowledgeable about this area. Hygienists more inclined to wear gloves, change them between patients, wear masks and protective uniform ($p<0.05$). Younger dentists sig. more likely to carryout these measures. Gloves most routinely used item. High numbers from all groups do not use protection to recap needles. Dentists and DSAs sig. more likely to suffer needlesticks ($p<0.05$). DSAs and hygienists sig. more likely to suffer puncture wounds ($p<0.05$). Few had sought serological follow-up testing.
Hastreiter et al. 1990	Survey Self administered questionnaire	Random sample of Licensed Minnesota hygienists and certified DSAs. 426/599 (71%) hygienists, 383/632 (61%) DSAs responded.	Demographics Practice profile HB immunisation treatment of infectious patients Use of barrier techniques Needlesick injuries Waste disposal Knowledge of AIDS	CDC Recommendations 1986	Over 80% of both always wear gloves, washing ands before gloving and once removed and changing them between patients. Hygienists were sig. more likely to wear gloves, change between patients, masks and face shield ($p<0.001$). In previous year DSAs more likely to have sustained needlesticks ($p<0.001$). Figures: DSA/Hygienist Only 1% / 5% felt they could have been expose to HIV. Of those who **DID**, none of the DSAs and only 11/22 hygienists sought antibody testing. 72% DSAs and 65% hygienists still

recap without protection. 26% / 31% offices still disposed of sharps in non-puncture resistant boxes. 53% / 59%. DSAs sig. more likely to have their HB vaccine paid for by employers ($p<0.001$). 55% / 51% felt dentist primary IC decision maker. Willing to treat patients with HBV 71% / 75% and for HIV 43% / 47%. Only 5%/8% felt dental office suitable place to treat HIV+.63%/80% knew measures for HBV sufficient for HIV. 34%/49% could recognise major oral manifestations. 36%46% felt they had enough information to adequately treat HIV+ patient. Compared with 66%//71% or HBV carriers.65%/61%had attended course within last year.33%/47% familiar with CDC Recommendations.

Howard 1989	Survey Self administered questionnaire	Random sample of English dental practices. 497/600 = 83% responses.	Sterilisation procedures Glove use Postgraduate IC courses.	Department of Health and Social Security 1986	86% practices did not sterilise handpieces. 97% use autoclave or dry heat steriliser for non-disposable instruments. 98% use sterilised set of instruments for each new patient. 60% use gloves routinely, 19% sometimes. 1% (4 practices) did not use a fresh needle for each patient. 42% ad attended IC course in last 18 months.
Walsh et al. 1995	Survey Self administered questionnaire	Random sample of Brisbane region dentists from Telephone Australia Brisbane Yellow Pages. 201/250 = 80.4% response.	Glove use patterns and objections to their use.	FDI 1993 CDC 1986, 1988, US department of Health and Human Services etc. 1991 National Health ad Medical Research Council 1987, 1992 Australian National Council on AIDS 1990 Worksafe Australia 1992, 1993.	84.6% wore gloves routinely. 13.9% did not wear them routinely and 3 who never used them excluded from analysis. Sig. difference between 2 groups in terms of experience ($p<0.03$). Practice profile and location not sig. associated. Adverse skin effects not sig. difference for 2 groups ($p<0.05$) 71.4% and 64.3% felt restriction of movement and sensation were reason for non routine wearing of gloves. 20.9% had receive needlestick injury n last year. No sig. association between sharp injuries ($p=.15$) and treatment of patients with infectious diseases ($p=1.00$).

McCarthy et al. 1997	Survey Self administered questionnaire	Licensed Ontario dentists. 5997 = 70.3% response rate.	Attitudes towards HIV Treatment of HIV+ patients IC procedures Willingness to treat Injuries	No guidelines mentioned or referenced.	NO sig. differences found between IC variables e.g. gloves, masks, HB vaccine, sterilisation of handpieces, use of extras for HIV+ patients and response time. Those who responded within 4 weeks more likely to; knowingly treat HIV patients ($p<0.001$); disagree with idea HIV+ ($p<0.05$)or AIDS patients should be treated in specialised centre ($p<0.001$). Also more likely to be willing to attend dentist which treats HIV+ ($p<0.01$), to belief chance of contracting HIV from needlestick is less than 1% ($p<0.01$) and to believe hat measures for HBV adequate for HIV ($p<0.05$). Nonresponse bias: 4 sig. associations; preference to refer HIV+ patients, unwillingness to attend dentist who treats HIV, belief AIIDS patients should be referred in centre, knowledge IC measures for HBV are sufficient for HIV.

McCarthy & MacDonald 1998	Survey Self administered questionnaire	Random sample of Ontario dentists from the Royal College of Surgeons of Ontario. 4003 in 1994 and 987 in 1995. 70.3% and 62.3% response rates respectively.	Barrier techniques HB vaccination Heat sterilisation handpieces IC precautions for HIV/AIDS.	ADA 1996 CDA 1992 CDC 1993, 1996	Routine use of gloves 91.8%/93.8%. Routine use of masks 73.3%/78.6%. Routine use of eyewear 82.5%/83.8%. HB vaccine 92%/90.9% - acquired immunity 0.6%/3.1%. HB vaccine for all clinical staff 63.9%/77.1%. Handpiece sterilisation 83.4%/95.2%. Extra precautions for HIV+ patients 875/52.3%. 788 dentists paired who took part I 1994 and 95 surveys. Sig. increase in use of gloves ($p<0.05$), masks ($p<0.00001$), HB vaccine ($p<0.05$), HB vaccine for staff ($p<0.001$), handpiece sterilisation ($p<0.00001$) and never taking extra precautions ($p<0.00001$). Responders more likely to report continuing education in AIDS in 1995 ($p<0.00001$).

ter Horst 1993	Survey Self administered questionnaire	Random sample of 378 (56%) of 669 practising Dutch hygienists and all 118 Amsterdam hygienists = 64% response rate. 240 Dutch and 76 Amsterdam.	Demographics Compliance with IC measures Treatment of HIVV+ patients Perceived knowledge, attitude, fear, behavioural aspects and experience of care for HIV+ patients.	Dutch Health Council guidelines mentioned but not referenced.	Only 2% did not wear gloves. 16% changed gloves between patients. Of those who wore gloves, 88% wore them during entire treatment. 85% wire masks. 46% of this group wore them all the time. 75% wore eyewear,50% f them wore them all the time. 87% used autoclave. Instruments seemed to be more often disinfected rather than sterilised however. Scores for overall compliance calculated. 85% had score of moderate or accurate compliance. 38% had poor compliance. 85% knew of DHC guidelines. 68% had purchased special equipment since the AIDS epidemic. 81% felt adequately informed about AIDS. 89% got information from dental lit., 78% media etc. 45% wanted additional training. Risk of infection from patient to hygienist was rated higher than hygienist to patient. Less perceived knowledge related with higher perceived risk of infection ($F=11.64$, $df=1.256$, $p<0.01$)Hygienists sure they had seropositive patients 5 tomes > likely to practice in Amsterdam ($x2=34.49$, $df=1$, $p<0.01$)More than 50% felt they should know patient HIV status. Arbitrary score of fear showed fear positively correlated with

estimation of risk of HIV infection ($F=3.48$, $df=2.158$, $p<0.03$) Hypotheses that hygienists from larger cities more stringent could not be confirmed. Only differences Amsterdam hygienists more likely to use a mask. No difference in perceived knowledge. Amsterdam hygienists less fearful ($t=4.32$, $df=191$, $p<0.01$).

Sivarajas-ingam & Ogden 1995	Survey Self administered questionnaire	Clinical staff and students at Dundee DH. 70/70 staff and 101/132 students = 77% response.	HB vaccine	BDA Advice Sheet A12 1991	All were aware of availability of HB vaccine. 9 students had not completed course - 7 were undergoing vaccination. 47 had their titre measured after last dose - 6 were inadequate response. Received booster.49% had failed to request titre check one year after last dose. 27% thought vaccine offered lifelong protection. 5 staff had not completed course but were undergoing. 47 requested titre test - 7 had poor response. 28% had not requested test.

Hartshorne et al. 1994	Survey Self administered questionnaire	South African dental and oral hygiene students. 30 oral hygiene students, 79 dental students. Good response rates.	Attitudes and perceptions of AIDS Exposure to HIV Knowledge of clinical signs and oral manifestations of HIV Important sources of information	CDC 1987, 1989, 1991.	All students equally aware of long symptomatic period ($p<0.05$). Fear of contracting infection by treatment f HIV+ patients similar for groups ($p<0.05$). Most students had fair knowledge of clinical signs. Sig. improvement in knowledge between first and second year oral hygiene students ($p<0.05$). Third year students ability to identify signs differed sig. from all other dental year groups ($p<0.05$)Students had poor perception of risk of contracting infection by needlestick injury. Some dental students unaware impressions should be disinfected. Some students felt gloves could be washed between patients. Final year dental students differed sig. in view they had received sufficient lectures ($p<0.05$). Most first year oral hygiene and third year dental students had gained information from popular press. 53.3% final year oral hygiene students said informal discussions principal source.

Scully et al. 1992	Observational study	Random sample of DH staff and students. 91 dentists, 40 students, 30 DSAs, 22 student hygienists carried out 183 procedures.	Treatments were surgical or restorative. Compliance with handwashing before and after patient contact Glove use Mask use Instrument clean-up.	CDC 1986, 1987, 1991. Council on Dental Therapeutics 1988	31% patient contacts neither gloves nor masks changed. 50% contacts eyewear not worn. 38% contacts masks not worn. Examination gloves worn for clean-up of surfaces. 4/44 possible cases heavy duty gloves worn for instrument cleaning. 38/44 exam gloves worn instead. Other 2 times no gloves worn.
Naidoo 1997	Cross-sectional study. Telephone survey questionnaire.	Dental students qualifying from University of Western Cape Town between 1985 and 1995 (n=173). Response rate = 87% (n=150)	Demographics HB vaccine IC practices	CDC 1993	52% reported needlestick injury in past 12 months. 97% followed no clear postexposure protocol, testing, etc. 85% felt at high risk of HBV infection. 93% report treating HBV infected patients. 92% wore gloves, 77% masks, 40% glasses for **all** procedures. 33% knew length of vaccine immunity. 68% had not checked their titre levels since last dose. 79% had injection five years ago. Only 32% had booster. Only 21% of rest of team had been vaccinated.

Epstein et al. 1995	Survey Self administered questionnaire	Dental specialists registered in B.C. 137/202 returned. Non respondents contacted by phone.	Knowledge of infectious disease IC practices	CDC 1991	84% reported HIV as the viral causation of AIDS. An average of 1.23 injuries were reported in the last 6 months. 82% immunised for HBV. 7% felt not necessary, 5% concerned with side effects, 5% did not give reasons. 71% routinely used and changed gloves, 25% washed and reused them. 92% disinfect or sterilise handpieces. 2/3 used heat process to treat handpieces. 41% felt sterilisation should be mandatory. 57% of these after each patient. 47% rinsed impressions before lab. 5% no rinsing or disinfecting. 82% disposed of sharps in proper container. 15% used special bag for clinical waste. The others put rubbish in general household collection. 80% request medical history of HBV and HIV.

Allsopp et al. 1997	Cross-sectional and longitudinal study - questionnaire based.	Random sample of dental practices in West Midlands, England. All members of the team. Family Practitioner Committee lists of Birmingham and Solihull. 122 dentists, 86 hygienists, 115 DSAs, 74 receptionists. 30 hygienists from 5 years earlier. 69.5% returned.	Work related symptoms Use of equipment which produces aerosols Use of PPE Surgery size Method of ventilation	COSHH 1989	Use of mask was sig. difference between all groups ($p<0.0001$) with nurses having lowest rate of masks and glasses ($p<0.0001$). Simultaneous use of mask and glasses reported by 43.6% hygienists, sig. higher than dentists (14.7%) and nurses (0%). Increased use was lowest in nurses group for masks ($p<0.0005$) and glasses ($p<0.05$) compared to dentists and hygienists. Details regarding symptoms related to work in staff - not relevant. Increased use of PPE from 54% to 71% for masks and glasses. Longitudinal study: 55 in study did not differ from general pop and so this study seems to have no particular effect. An increase occurred anyway generally over 5 years.

Kunzel & Sadowsky 1993	Survey Self administered questionnaire	Random sample actively practising US dentists from ADA master file. 1351/1832 = 88% responded.	Perceived level of professional risk Knowledge of transmission routes Exposure to information Protective behaviours Exposure to risk Ethical obligation.	No guidelines apparent	31%dentists disagreed with idea HIV+ patients can be treated safely in offices. 30% had no worry, 10% were very worried about risk of infection. 65% had faith in effectiveness of barrier techniques. 3% felt the opposite. 75% attributed highest level of risk to needlestick injury to someone with AIDS. 25% felt blood splash on skin had same risk. The grater the level of perceived staff opposition to treatment of AIDS patients, the greater the level of risk attributed to them. Lower perception of risk associated with ethical obligation to treat. The higher the level of certainty of having treated HIV+ patients, the lower the perceived risk. Level of risk attributed to exposure accidents positively related to level of perceived risk. Perceived risk sig. positively related to concern of treatment of homosexuals. Perceived risk sig. negatively related to exposure relevant education, engaging in IC behaviours, number patients see per week.

Kunzel & Sadowsky 1991	Self-report questionnaire -based survey.	Random stratified , computer generated sample of 1832 practising U dentists from 6370 appearing in ADA master file. 1351 questionnaires returned = 88% response rate. Answers were divided according t practice locale: central cities, other urban areas, rural areas.	Willingness of dentists to treat high risk patients.	No specific guidelines referenced.	Willingness to treat not sig. asscoaited with practice locale. Locale was associated with pereptions of exposure to HIV by paite contact. Dentists from central cities moe likel y to think they had treated high risk patients. 97% felt they had right to know HIV antibody status of the patient. Rural dentists tended to not be willing to treat homosexuals because o HIV links. They had greater concerns about treating HIV carriers compared with HBV carriers. Three quarter of dentists from all three practice locales believed that other patient would leave the practice if they knew high risk patients were being treated there. Dentists showed good overall knowledge of infection control. But 56% believed incorrectly that saliva can transmit HIV. Solo practices tended to be located in rural settings.

Wood 1995	Fixed response survey - questionnaire .	Random sample of registered hygienists and certified DSAs from Rhode Island. 171/267 hygienists, 153/260 DSAs = 64% and 59% response respectively. Samples represented 27% and 34% of total pops.	Demographics IC practices Perceptions of decision making within dental office Participation in education courses Existence of written protocols.	ADA 1992 CDC 1986, 1993 OSHA 1991, 1992 American Association of Dental Schools Guidelines 1991	71% CDAs responsible for majority of instrument sterilisation. RDHs had this duty in only 3% offices. From RDHs viewpoint, equal 27% reported CDA and 23% RDH's responsibility. Selection of IC products duty of CDA for 52% and dentist 24% according to CDAs and 30% CDA and 25% dentist 19% hygienist in case of RDHs. 74% CDAs and 75% RDHs had attended course within last 12 months. CDAs reported written protocols in place for occupational exposure (87%), clean up (74%), instrument sterilisation etc. (79%). RDHs reported 83%, 74%, 80% respectively. For CDAs 99% gloves, 84% masks, 70% eyewear, 21% shields. For RDHs 99% gloves, 94% masks, 59% eyewear, 14% shields. Grouping together according to guidelines data not as encouraging. 73% CDAs and 76% RDHS washed before gloving while 845 and 87% did so after. Only 50% CDAs and 46% RDHs placed disposable barriers on light handles. 70% and 55% used single handed resheathing or a shield . 24% and 25% report using two handed technique. 91% and 89% placed needles in sharps container. 89% and 67% reported always sterilising handpieces. 3% and 12%

disinfected only ($p<0.01$) 91% and 92% were disinfecting surfaces. 46% and 54% flushes waterlines at start of each day. 44% and 42% scrubbed and used ultrasonic cleaner or instruments before sterilisation. 57% and 61% used heavy duty gloves t clean. 87% and 77% used markers to check autoclaves freq. 65% and 86% reported taking or updating medical history ($p<0.001$). 88% and 93% used gloves to develop radiographs.

Gilbert & Nuttall 1994	Survey Self administered questionnaire	Deans of UK dental schools contacted for access to final year students. 15/16 schools. 447/739 = 60.5% response.	IC practices Knowledge of HIV and Treatment of HIV+ patients.	BDA Advice Sheet A12 1991 CDC 1988, 1989, 1991	42% felt IC education received was more than adequate. 29% felt barrier dentistry was less than adequate and 31% felt management of blood borne virus carriers was also less than adequate. 15% did no know length of time between contracting HIV and production of antibodies. 91% believe person carrying anti IV antibodies would be an HIV carrier. 97% recognised association between HIV and hairy leukoplakia, 99% HIV and Kaposi's sarcoma, 95% HIV and oral candidiasis. 66% thought association existed between HIV and salivary gland enlargement. Less than 50% recognised link between HIV and encephalopathy, oral melanotic hyperpigmentation, idiopathic thrombocytopenic purpura and seborrhoeic dermatitis. 99% recognised tat broken skin in contact with HIV infected blood is possible route of transmission.. 64% believed same for broken skin and saliva of HIV+ person. 76% inhalation of aerosol containing blood of HIV+ patient. 13% felt unbroken skin in contact with blood was possible route of transmission.

Snyder 1993	Survey Self administered questionnaire	Random sample of Licensed Pennsylvanian dental hygienists. Total pop. 4209. 220/300 returned. Only 154 useable = 64% response rate.	Demographics IC practices Attitudes to AIDS patients Knowledge of IC practices.	American Association of Dental Schools 1991 CDC 1985, 1986, 1988 OSHA 1992	94.2% had adequate knowledge about AIDS. 54% expressed concern about treating AIDS patients. 28% were very worried. 3% overwhelmingly so. 53% felt hygienists should not be required to treat HIV+ patients. 93% showed comprehensive knowledge of IC procedures. 71% know measures for HBV sufficient for HIV. 69.5% had been inoculated against Hepatitis B. 87.5% wear masks, 88.2% glasses, 98% wear gloves **for all patients**. 96.8% routinely disinfect light handles, 98.7% bracket trays, 96.7% chair switches. Relationship between knowledge and implementation using Spearmans Rho .22. Weak negative correlation between knowledge about AIDS and attitude scores about AIDS ($r=-0.088$, $p<0.05$) Weak negative correlation between attitudes towards AIDS patients and use of IC practices ($r=-0.20$, $p<0.05$). Use of IC practices seems to be associated with less fear concerning the treatment of HIV+ patients (??). Sig. difference between infection control practices for routine patients and those HIV infected. ($p<0.05$).

Burke et al. 1994	Survey Self administered questionnaire	Random sample of English and Welsh dentists, practising within NHS Regulations. 1605/2000 = 80% response in 1989. 1200/2000 = 61.5% response in 1991/92.	Compliance with IC practices Trends in glove use	CDC 1986 Council on Dental Materials etc. 1988 FDI 1989	723 matched pairs identified from sample of 1989 and 1991/92. Sig. difference in glove wearing between 1989 and 1991/92 ($p<0.0001$). 10.2% wore them for each patient in 1989 and 18.8% in 1991/92. Cost was considered to be reason for not reusing gloves by 58.5% in 1989 and 60.8% in 1991/92. Glove washing showed no sig. change. Those who wore gloves occasionally tended t do so when treating high risk patients. Oral surgery (29.3%) and scaling (13.8%) were procedures for which gloves were worn most often. Routine and occasional glove wearers reported difficulties with performing specific procedures more in 1989 (70.8%) compared to 1991/92 (65.5%). 63.5% DSAs wore gloves routinely in 1991 compared to 51.6% in 1989. NO sig. change in heavy duty glove wearing 40.3% in 1989 and 38.2% in 1991). Minimal change in mask wearing: 30.3% in 1989 and 34.9% in 1991. Autoclave use: 89.5% in 1989 and 94.2% in 1991. No. of patients with HIV treated unchanged at 54.3%. Needlestick injuries remained similar 36% in 1989 and 35.5% in 1991. Puncture wounds by instruments 46.7% in 1989 to 39.9% in 1991.

Burke et al. 1994	Survey Self administered questionnaire	Random sample of English and Welsh dentists, practising within NHS Regulations. 1605/2000 = 80% response in 1989. 1200/2000 = 61.5% response in 1991/92.	Compliance with IC practices Trends in glove use	CDC 1986 Council on Dental Materials etc. 1988 FDI 1989	Further analysis carried out on a subset of orthodontists identified. Findings only reported at time2 1991/92. Of 40 orthodontists, only 3 reported wearing a mask routinely. 25% never wore a mask to protect against aerosols. 60% wore gloves routinely but only 17% changed them between patients. They washed them instead. 38% of orthodontists' DSAs wore gloves routinely nut an unusually high 50% wore heavy duty gloves for instrument cleaning. 54% of DSAs reportedly spend 1-3 minutes between patients. 33% spend less than one minute.
Gerbert et al. 1988	Survey Self administered questionnaire	Random sample of Licensed dentists, hygienists, DSAs in California. 6 counties selected. Rosters of DHCWs licensed in California provided by State Licensing Boards. 297 (65%) dentists, 128 (62%) hygienists, 171 (44%) DSAs responded.	Willingness and competence to care for HIV+ patients and high risk groups. Knowledge of risk groups and transmission f HIV Attitudes towards providing care IC procedures Perception or percent of patients at risk.	CDC Recommendations 1986	Dentist > 43 years sig. less knowledgeable ($p<0.015$), attitudes which represented barriers to care those with AIDS ($p<0.002$), perform fewer IC procedures ($p<0.002$). Scores for knowledge and attitude sig. higher for dentists and hygienists. IC practised sig. more by hygienists than dentists or DSAs. NO groups attained ideal score. 80% believed others would not wish to continue in their care if they were treating HIV+ patients. Less than half dentists and hygienists and only 18% DSAs felt they had the skills needed to treat HIV+ patients. 70% preferred to refer

high risk patients yet 65% they had a duty to treat!! Low correlations between knowledge and attitude, knowledge and IC ($r<.20$). Higher correlations found between attitude scores and IC scores ($r=.402$ hygienists, $r=.229$ for dentists and $r=.227$ for DSAs). Each category believed only 2% patients at risk. Those who judged their to be more patients at risk used more IC measures. ($f=9.99$, $p<0.0001$) and attitudes ($F=5.99$, $p<0.004$). They were also more likely to take a thorough medical ($F=4.32$, $p<0.02$) and sexual history ($F=3.44$, $p<0.04$). Knowledge scores did not differ sig. in terms of perceived percent f patients at risk.

Scheutz & Langebaek 1995	Survey Self administered questionaire and control indeicator strip.	Random sample of Danish dentists from Danish Dental Association Register. 249/335 = 74.3% response.	IC practices HIV and HBV infection Treatment of infectious patients	FDI 1993	1986-1993 IC improved. 17.3% always use gloves compared with 0.6% in 1987. Only 25.3% increase in use of gloves when extracting or oral surgery. 51.5% believe gloves most important barrier. 60.2% reported at least one needlestick injury within last year. In 1987 56% reported these . 94.3% used autoclaves to sterilise instruments. 3.4% did not pass efficiency test with strip. Age not reason - half failures had been purchased within last 5 years. 60% considered risk of becoming infected through treating patients very small. 1.6% perceived it as great. View on risk had not changed since 1987 ($p<1.00$). Willingness to treat HIV patients has increased from 56.1% to 78.7% and the number of clinics reporting safe treatment of these patients 43% to 66.8%. Details of logistic regression model given.

Lloyd et al. 1995	Survey Self administered questionnaire	Random sample of English dentists from BT Electronic Yellow Pages. 267/500 = 53.4% responded.	Handpiece sterilisation techniques Attitudes towards Handpiece sterilisation Difficulties associated with it.	CDC 1986 Council on Dental Materials 1992 BDA 1987	34.2% flushed waterlines between patients. 20.2% believed risk of contamination of handpiece was negligible, 48.3% low, 25.9% high. 79.5% believed sterilisation would prevent cross infection via this route. 88.8% had upgraded their handpiece asepsis within the previous 5 years. 43.9% sterilised between patients. 31.2% several times per day, 28.2% used disinfectant, 8.9% sterilised handpiece once per day. 90.6% possessed autoclavable handpieces 45.9% autoclaved them after every patient, 54.1% did not. 79.2% of those who autoclave stated adverse effects on handpiece. Those who did not autoclave regularly, 83.3% stated adverse effects. Those who did not own autoclavable handpieces, 77.3% subsidising from government would encourage them. 54.5% worried about harm of autoclaving the and 45.5% worried about cost.

Evans 1989	Self-report questionnaire -based survey	285 questionnaires sent to specialists belonging to the British Association of Orthodontists, Consultant orthodontists and the British Society for the Study of Orthodontics who were working as specialist practitioners, in the community, as GDPs or in hospitals.	Current opinions held by orthodontists in the United Kingdom.	ADA (1985) and BDA (1987) guidelines.	62% of sample had been vaccinated against hepatitis B and 30% were considering it. No sig. diff. In uptake among four employment groups. One third of sample never wore gloves. 215 wore gloves for all patients. Specialist practitioners were lest likely to wear gloves. 30% sterilised pliers using autoclave. Matrix band s autoclaved in 49% of practices. Disinfectant solutions often used instead. 72% had never sterilise impressions.
McCarthy & Koval 1996	Follow-up questionnaire based survey.	Practising dentists from London, Ontario who appeared on list of Royal College f Dental Surgeons of Ontario. 258 questionnaires were posted in 1992 and a 70% response rate achieved. In 1994, 262 questionnaires were sent out and 76% returned.	Changes in dentists' knowledge, attitudes and practice. Attendance at postgraduate courses and demographics.	CDC 1993 guidelines.	Half of the respondents attended postgraduate courses in 1992 and rose to 80% in 1994 - a sig. change ($p<0.001$). Glove use remained high and changing of gloves increased from 94% to 98%. 88% used masks in 1992 and 95% in 1994. Handpieces sterilisation rose from 68% in 1992 to 85% in 1994, perhaps due to media coverage. Dentists' willingness to treat high risk patients rose from 68% to 77%. Pairwise analysis of 85 subjects revealed sig. changes in the wearing f masks ($p<0.01$), the sterilising of handpieces ($p<0.05$).

Scherer et al. 1989	Self-report questionnaire based survey.	Department of Operative Dentistry in New York University College of Dentistry sent Qs to all chairpersons of operative departments of all 58 US dental schools. 35 out of 58 schools responded.	Sterilisation methods assessed.	No specific guidelines referenced.	75% of stainless steel hand instruments were autoclaved in comparison with 53% of the carbon steel equivalent. Burs not routinely autoclaved. 25% of steel burs, 33% of carbon steel burs and 39% o tungsten-carbide burs put through the system. 39% autoclaved handpieces. Cold sterilisation proved next most popular option.
Jacobson et al. 1989	Questionnaire based survey. Lectures and seminars were given to subjects an recruitment to a hepatitis B vaccination programme assessed.	Students, faculty an staff at Michigan School of Dentistry, USA were surveyed between 1984 and 1985.	Participation in hepatitis B vaccination programme. Assessment of the programme and it uptake.	ADA 1982, CDC 1983, OSHA 1983 recommendations. Regional Health Department guidelines.	667 subjects too part. 93% of student sample, 51% of faculty members and 29% of staff participated. Overall acceptance rate of 69%. 312 potential subjects did not take part. Association identified between programme and patient contact ($p<0.0005$). Less patient contact time, less likely one is to participate. Participants were more likely to feel susceptible to hepatitis B. Non-participants more likely to see barriers to acceptance e.g. costs, side effects and time implications. Participants older than 45 years of age were more likely to have a lower perceived severity of hepatitis B ($p<0.001$).