the Journal of CONTEMPORARY DENTAL PRACTICE at www.thejcdp.com
Volume 8 Number 3 March 1, 2007

HIV: Infection Control Issues For Oral Healthcare Personnel

Michaell A. Huber, DDS; Geza T. Terezhalmy, DDS, MA

Abstract

Aim: To present the essential elements of an infection control/exposure control plan in the oral healthcare setting with emphasis on HIV infection.

Methods and Materials: A comprehensive review of the literature was conducted with special emphasis on HIV-related infection control issues in the oral healthcare setting.

Results: Currently available knowledge related to HIV-related infection control issues is supported by data derived from well-conducted trials or extensive, controlled observations, or, in the absence of such data, by best-informed, most authoritative opinion available.

Conclusion: Essential elements of an effective HIV-related infection control plan include: (1) education and training related to the etiology and epidemiology of HIV infection and exposure prevention; (2) plans for the management of oral healthcare personnel potentially exposed to HIV and for the follow-up of oral healthcare personnel exposed to HIV; and (3) a policy for work restriction of HIV-positive oral healthcare personnel.

Clinical Significance: While exposure prevention remains the primary strategy for reducing occupational exposure to HIV, knowledge about potential risks and concise written procedures that promote a seamless

response following occupational exposure can greatly reduce the emotional impact of an accidental needlestick injury.

Keywords: HIV infection, exposure control, AIDS, HIV prevention

Citation: Huber MA, Terezhalmy GT. HIV: Infection Control Issues For Oral Healthcare Personnel. J Contemp Dent Pract 2007 March;(8)3:001-012.

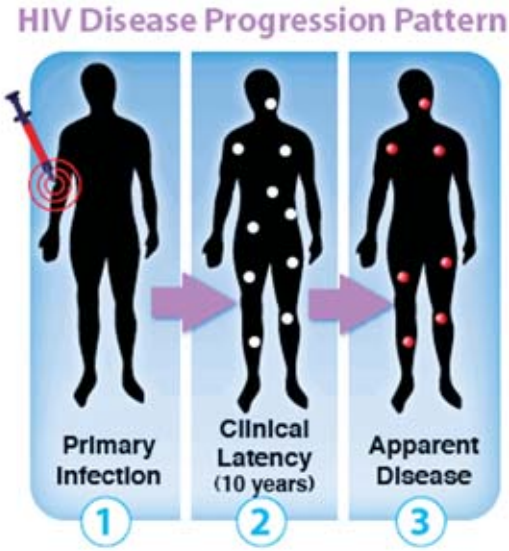
Introduction

The Centers for Disease Control and Prevention (CDC) estimate over one million persons are infected with HIV in the United States. Since HIV infection is now being successfully managed as a chronic disease, an increasing number of these patients are seeking dental care. Exposure prevention remains the primary strategy for reducing occupational exposure to HIV. However, percutaneous and mucosal exposure to HIV-infected blood can and does occur in oral healthcare facilities. This article presents a hierarchy of preventive strategies to reduce the risk of occupational exposure and a discussion of the management of oral healthcare personnel potentially exposed to HIV.

Etiology and Epidemiology

Initially described over 25 years ago[1], the acquired immunodeficiency syndrome (AIDS) represents the predominant clinical manifestation of advanced infection with the human immunodeficiency virus (HIV).[2] While individual variations exist, a common pattern of disease progression has been established consisting of three phases: (1) primary infection, (2) prolonged (median=10 years) period of clinical latency, and (3) the appearance of clinically apparent disease.[3] The immunopathologic mechanisms have only partially been identified, but the available scientific evidence clearly reveals a dynamic process in which the initial and ongoing immunological response to HIV infection is not only unsuccessful in clearing the HIV but is paradoxically paralleled by a progressive reduction in immunocompetence.[4] The end-point of this progressive reduction in immunocompetence is AIDS which is defined as the presence of one or more of the indicator conditions in association with HIV infection.[5-6] The prime modes of transmission for HIV[7] include:

1. Unprotected penetrative sex between men
2. Unprotected heterosexual intercourse
3. Injection drug use
4. Unsafe injections and blood transfusions
5. Mother to child spread during pregnancy, delivery, or breast feeding



For healthcare workers, the risk of HIV transmission in an occupational setting appears to be remote.[8] As of December 2002, the Centers for Disease Control and Prevention (CDC) reported 24,844 patients with AIDS had a history of employment in healthcare, and occupational

exposure to HIV was confirmed or possible in only 57 and 139 of the cases, respectively. For the 57 confirmed occupationally acquired cases, 88% were associated with a percutaneous injury.[9] To put these numbers in perspective, it is estimated 17 to 57 healthcare workers per million die annually from occupationally acquired infectious disease (hepatitis B, hepatitis C, HIV, or tuberculosis).[10] For comparative purposes, the annual death rates among construction workers is 1,081 to 1,452 per million, among military personnel 361 per million, and among truck drivers it is 157 to 208 per million.

Estimates of HIV infection and AIDS are usually obtained utilizing both population-based and sentinel surveillance data.[11] As of December 2005, the World Health Organization (WHO) estimated 36.7 to 45.3 million (16.2 to 19.3 million women, 18.4 to 23.2 million men, and 2.1 to 2.8 million children <15 years of age) individuals worldwide were infected with HIV with 4.3 to 6.6 million becoming newly infected in 2005.[12] Regionally, 77% of all persons infected with HIV live in Sub-Sahara Africa. In the United States, the CDC estimates over one million persons are infected with HIV.[13] Since the pandemic began, an estimated 25 million individuals have succumbed to AIDS with an estimated 2.8 to 3.6 million of those deaths occurring in 2005.[12]

Clinical Manifestations

The clinical manifestations of HIV infection/AIDS have been extensively reviewed. During the primary phase of HIV infection, 50% to 80% of patients experience an acute retroviral syndrome.[14] This syndrome manifests numerous non-specific signs and symptoms such as fever, lethargy, malaise, sore throat, arthralgias, myalgias, headache, photophobia, maculopapular rash, and lymphadenopathy.[4] During the period of clinical latency, the patient is typically free of overt clinical illness. Progression to the final phase of overt clinical disease (AIDS) is characterized by the occurrence of one or more defined indicator diseases (Table 1).[5-6]

Diagnosis

The diagnosis of HIV infection is obtained via appropriate laboratory testing.[15] In the standard HIV-antibody test algorithm, a plasma or serum sample is subjected to an enzyme-immuno assay (EIA). If the result is positive, a second EIA is performed; and if that result is positive, a confirmatory Western blot analysis is performed. This algorithm is highly sensitive and specific

Table 1. Indicator diseases of AIDS.[5]

1. Candidiasis of bronchi, trachea, or lungs	14. Lymphoma, Burkitt's (or equivalent term)
2. Candidiasis, esophageal	15. Lymphoma, immunoblastic (or equivalent term)
3. Cervical cancer, invasive	16. Lymphoma, primary, of brain
4. Coccidioidomycosis, disseminated or extrapulmonary	17. Mycobacterium avium complex or M. kansasii, disseminated, or extrapulmonary
5. Cryptococcosis, extrapulmonary	18. Mycobacterium tuberculosis, any site (pulmonary or extrapulmonary)
6. Cryptosporidiosis, chronic intestinal (greater than one month's duration)	19. Mycobacterium, other species or unidentified species, disseminated or extrapulmonary
7. Cytomegalovirus disease (other than liver, spleen, or nodes)	20. Pneumocystis carinii pneumonia
8. Cytomegalovirus retinitis (with loss of vision)	21. Pneumonia, recurrent
9. Encephalopathy, HIV-related	22. Progressive multifocal leukoencephalopathy
10. Herpes simplex: chronic ulcer(s) (greater than one month's duration); or bronchitis, pneumonitis, or esophagitis	23. Salmonella septicemia, recurrent
11. Histoplasmosis, disseminated or extrapulmonary	24. Toxoplasmosis of brain
12. Isosporiasis, chronic intestinal (greater than one month's duration)	25. Wasting syndrome due to HIV
13. Kaposi sarcoma	

with reported false positive rates ranging from 1 in 130,000 to 1 in 251,000.[16] However, cases of recent HIV infection may be missed, as it takes several weeks, and at times months, for a measurable antibody response to develop. As a consequence, several other testing methods targeting HIV antibody and HIV antigen identification have been developed and approved by the Food and Drug Administration (FDA).[17] Many purport to be more convenient, less invasive, and provide a quicker result than the standard testing scheme. In a recently published report, the investigators demonstrated adding nucleic acid amplification to the standard HIV testing algorithm significantly increased the identification of HIV positive patients in the acute phase of infection.[18]

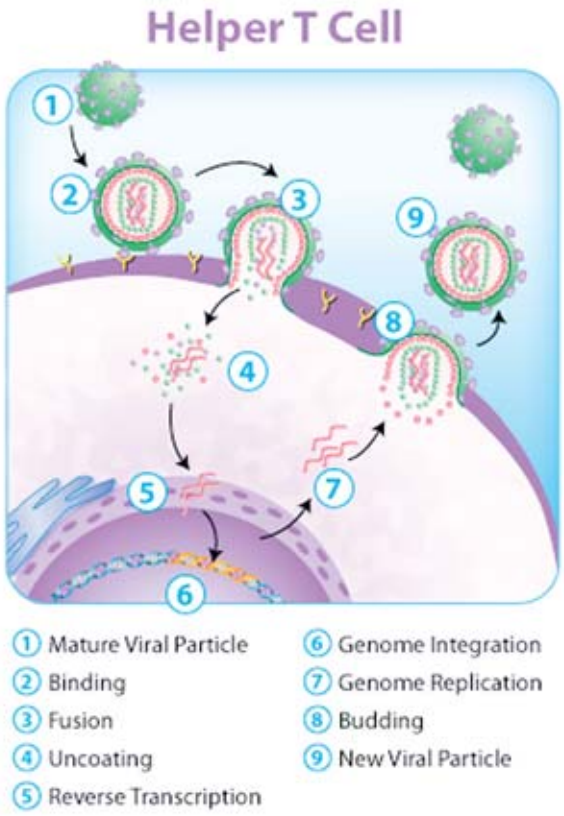
Determining who should be tested for HIV infection represents an area of ongoing debate.[19] There is no argument patients at high risk for exposure to HIV (i.e., injection drug users, men having sex with men, sexually active men, and women with multiple partners) or those presenting with signs and symptoms suggestive of HIV infection should be tested.[16,20] However, in a recent study evaluating the cost effectiveness of providing HIV screening for populations with a 1% or greater prevalence of undiagnosed HIV infection, the authors concluded routine, voluntary screening once every three to five years was justified.[21] They noted when screening those at highest risk, the mean CD4 cell count at detection was raised from 154 to 210 per cubic millimeter which equated to an earlier diagnosis and an opportunity to institute earlier therapeutic interventions.[21]

Principles of Medical Management

With minor variations, the HIV has the same general life cycle as other viruses. Infection begins when a virion attaches to a host cell. Viral proteins (capsid- or envelop-related) mediate attachment by binding specific receptors on host cell membrane. Viral entry into the host cell is mediated by other viral proteins which promote the fusion of the viral capsid or envelop with host cell membrane. Once the virus has gained entry into the host cell, it looses its capsid proteins by the process known as uncoating and the viral nucleic acid now becomes available for genome replication. Replication requires the generation of protein kinase-dependent nucleoside triphosphates (ribo- or deoxyribo-) which are incorporated into the new viral genome by viral or cellular polymerases. In most instances the viral DNA or RNA is replicated and then transcribed into mRNA. For retroviruses, such as the HIV, uncoating is followed by reverse transcription, the viral RNA is first copied into DNA before it is transcribed into mRNA. Next, the newly synthesized mRNA is translocated to host cell ribosomes. The viral proteins synthesized by host cell ribosomes are then assembled with the duplicate viral genome. Assembly is followed by maturation which involves cleavage of viral proteins by proteases essential for the newly formed virion to become infectious. In the case of HIV, viral egress from the cell precedes maturation and may be either by budding through the cell membrane or cell lysis.

Mechanisms of Action of Anti-HIV Drugs

Currently available anti-HIV drugs exploit structural and functional differences between viral and human proteins. These include (1) a fusion inhibitor; (2) inhibitors of viral genome replication (nucleoside reverse transcriptase inhibitors [NRTIs], a nucleotide reverse transcriptase inhibitor [NtRTI], and non-nucleoside reverse transcriptase inhibitors [NNRTIs]); and (3) protease inhibitors (PIs).[22] The treatment of HIV infection requires combination therapy known as highly active antiretroviral therapy (HAART). Anti-HIV regimens currently recommended for the treatment of naïve patients may be NNRTI-based (1 NNRTI + 2 NRTIs); PI-based (1 or 2 PIs + 2 NRTIs); or triple NRTI-based (3 NRTIs). The treatment of patients with acute HIV infection,



HIV-infected adolescents, injection drug users, HIV-infected women of reproductive age and pregnant women, and patients with co-infections (HBV, HCV, and tuberculosis) require special antiretroviral regimens.

Inhibitors of Viral Fusion

Enfuvirtide

Enfuvirtide is the first antiviral agent that inhibits viral entry into host cells. It is an anti-HIV peptide structurally similar to a segment of the HIV protein (gp41) that mediates membrane fusion.

Inhibitors of Viral Genome Replication

NRTI

All retroviruses contain an RNA genome and their capsids contain the enzyme reverse transcriptase essential for HIV replication. Reverse transcriptase is a DNA polymerase, which copies the RNA retrovirus genome into double-stranded DNA. Once the viral DNA is integrated, cellular RNA polymerase copies it into a genomic RNA and a mRNA that encodes the various viral proteins. NRTIs mimic deoxyribonucleoside triphosphate, the natural substrate for reverse transcriptase. As they become incorporated into the growing DNA chain, they terminate elongation and decrease or prevent HIV replication in infected cells. NRTIs include abacavir, didanosine, entricitabine, lamivudine, stavudine, zalcitabine, and zidovudine.

NtRTI

Nucleotides are phophorylated nucleosides. Nucleoside and nucleotide RTIs have similar mechanisms of action. The only currently available NtRTI is tenofovir.

NNRTIs

NNRTIs bind near the catalytic site of reverse transcriptase and inhibit a crucial step in the transcription of the RNA genome into a double-stranded retroviral DNA. NNRTIs include delavirdine, efavirenz, and nevirapine. Combinations of NRTIs and NNRTIs tend to be at least additive in reducing HIV replication.

Protease Inhibitors

Following duplication of the viral genome and structural protein synthesis, viruses must undergo assembly and maturation. Viruses, such as the HIV, encode proteases. Proteases cleave viral proteins during assembly and maturation, a process essential for the newly formed virus to become infectious. Protease inhibitors (PIs) include amprenavir, atazanavir, fosamprenavir, indinavir, lopinavir, nelfinavir, ritonavir, saquinavir, and tipranavir. The use of PIs with other antiretroviral drugs has lead to marked clinical improvement and prolonged survival of patients with advanced HIV infection.

Prevalence of Oral Disease

Numerous oral lesions have been associated with HIV infection (Table 2) with the most notable being candidiasis (erythematous, pseudomembranous), hairy leukoplakia, Kaposi's sarcoma, Non-Hodgkin's lymphoma, and periodontal disease (linear gingival erythema, necrotizing ulcerative periodontitis).[23] Hairy leukoplakia and oral candidiasis have been demonstrated to be positive predictors of HIV

Table 2. Oral lesions associated with HIV infection.[23]

Group 1 Lesions strongly associated with HIV infection	Candidiasis Erythematous Pseudomembraneous Hairy leukoplakia Kaposi's sarcoma Non-Hodgkin's lymphoma Periodontal disease Linear gingival erythema Necrotizing (ulcerative) gingivitis Necrotizing (ulcerative) periodontitis
Group 2 Lesions less commonly associated with HIV infection	Bacterial infections *Mycobacterium avium-intracellularae* *Mycobacterium tuberculosis* Melanotic hyperpigmentation Necrotizing (ulcerative) stomatitis Salivary gland disease Dry mouth due to decreased salivary flow rate Unilateral or bilateral swelling of major salivary glands Thrombocytopenia purpura Ulceration NOS (not otherwise specified) Viral infections Herpes simplex virus Human papillomavirus (warty-like) lesions Condyloma acuminatum Focal epithelial hyperplasia Verruca vulgaris Varicella-zoster virus *Herpes zoster* Varicella
Group 3 Lesions seen in HIV infection	Bacterial *Actinomyces israelii* *Escherichia coli* *Klebsiella pneumonia* Cat-scratch disease Drug reactions (ulcerative, erythema multiforme, lichenoid, toxic epidermolysis) Epithelioid (bacillary) angiomatosis Fungal infection other than candidiasis *Cryptococcus neoformans* *Geotrichum candidum* *Histoplasma capsulatum* *Mucoraceae (mucormycosis zygomycosis)* *Aspergillus flavus* Neurological disturbances Facial palsy Trigeminal neuralgia Recurrent aphthous stomatitis Viral infections Cytomegalovirus Molluscum contagiosum

disease progression.[24-25] However, while it is generally agreed HIV-associated oral lesions are useful markers of HIV disease, their true prevalence is unknown.[26-28]

Improved pharmacological strategies, specifically highly active antiretroviral therapy (HAART), appear to modulate the prevalence of HIV-associated oral lesions. HAART also dramatically improves laboratory profiles (increased CD4 counts, decreased viral load). In a study of 577 HIV infected adults, HAART therapy was associated with a decreased prevalence of hairy leukoplakia and necrotizing periodontal disease and an increased prevalence of salivary gland disease.[29] In the same study the effect of HAART on the prevalence of oral candidiasis, aphthous ulcers, oral warts, herpes simplex virus lesions, and Kaposi's sarcoma was not significant. In a study of 459 HIV-positive children in Brazil, the prevalence of hairy leukoplakia was significantly lower for those undergoing HAART compared to other antiviral regimens.[30] It has been postulated the seemingly paradoxical persistence and at times worsening of HIV-associated lesions is due to the phenomena of immune reconstitution disease.[31-34]

Principles of Dental Management

Since HIV infection is now successfully being managed as a chronic disease, patients are living longer and are healthier. As a consequence, an increasing number of these patients are likely to seek dental care. Oral healthcare providers have both a moral and legal obligation to treat HIV-infected patients within the scope of their practice.[35-36]

For patients with a known HIV infection, the practitioner must obtain a thorough medical history including a meticulous review of systems, determination of current disease status (i.e., CD4 counts, viral load), and a listing of all medications. Medically well-controlled patients can generally tolerate the delivery of routine dental care.[36-37] Circumstances that may necessitate a modification to the delivery of routine dental care are typically observed in advanced stages of disease (i.e., AIDS) and include low CD4 counts (<200/mL), reduced platelet levels (<60,000/mm^3), and severe neutropenia (<500/mm^3).[36,38]

In addition, preventive strategies to optimize oral hygiene, establish a regular recall schedule, screen for HIV-associated oral lesions, and drug-induced side-effects should be instituted.[36] Routine monitoring for HIV-associated oral lesions in all patients serves two important purposes. In known HIV-infected patients the occurrence of HIV-associated oral lesions may signal a less than optimal response to treatment, usually due to poor patient compliance and/or the development of antiretroviral drug-resistance.[39] In undiagnosed HIV infected patients the presence of such lesions may represent the first clinical manifestation of infection.

Issues Related to Infection Control/Exposure Control

The Risk of HIV Transmission from Patients to Healthcare Personnel

The transmission of HIV infection from patients to healthcare personnel (HCP), all paid and unpaid persons working in the healthcare setting who may potentially be exposed to blood and other potentially infectious materials (OPIM), may occur after percutaneous (cut with a sharp instrument or needle stick) and, infrequently, mucocutaneous exposure to blood and other body fluids containing blood. A retrospective case-control study found the risk of infection among HCP following percutaneous exposure to HIV-infected blood was more likely (1) in the presence of visible blood on the instrument before injury, (2) if the injury involved a needle which was placed directly into the patient's vein or artery, (3) if the injury caused by the contaminated instrument or

needle was deep, or (4) if the source patient has an increased viral load, i.e., was terminally ill.[40-41] Prospective studies of HCP estimate the average risk for HIV infection after percutaneous and mucous membrane (eyes, nose, mouth) exposure to HIV-infected blood is approximately 0.3% and 0.09%, respectively.[42-43] The transmission of HIV infection after nonintact skin exposure has been documented.[44] The average risk of transmission by this route has not been quantified, but it is estimated to be less than the risk following mucous membrane exposure.[45] Similarly, the risk of transmission after exposure to fluids or tissues other than HIV-infected blood is probably considerably lower than the risk following exposure to blood.[42,46] As of 2002, occupational exposure to HIV was confirmed in 57 HCP, and of these none were oral healthcare personnel (OHCP).[9] Clearly, the risk of HIV transmission in the oral healthcare setting is extremely low in the United States.

Exposure Prevention in the Oral Healthcare Setting

Exposure prevention remains the primary strategy for reducing occupational exposure to HIV. Historically, infection control guidelines focused primarily on the risk of transmission of bloodborne pathogens among HCP and patients and the use of universal precautions to reduce the risk. Universal precautions were based on the concept blood and body fluids contaminated with blood should be treated as infectious because patients with bloodborne infections can be asymptomatic and unaware they are infectious. The CDC expanded the concept of universal precautions into the concept of standard precautions. Table 3 presents a hierarchy of preventive strategies to prevent or reduce the risk of occupational exposure to blood and OPIM within the concept of standard precautions.[47]

Management of Oral Care Healthcare Personnel (OHCP) Potentially Exposed to HIV

Oral healthcare facilities should have, as part of their infection control/exposure control protocol, the organizational infrastructure that promotes a seamless response following occupational exposure. It should include clear written procedures for prompt reporting, evaluation, treatment, and follow-up.[48] Access to clinicians who are familiar with post-exposure evaluation and treatment protocols, by creating linkage to another healthcare facility or physician, should be made available during all working hours (including nights and weekends). OHCP should be familiar with the principles of post-exposure management, in particular with the importance of reporting exposures immediately after they occur, because post-exposure prophylaxis (HIV PEP) is most

Table 3. Standard precautions: a hierarchy of preventive strategies.

Immunization	No anti-HIV vaccine available at this time
Personal Protective Equipment	Prevent or reduce the risk of exposure Examples: gloves; surgical mask; protective eyewear; and protective clothing
Engineering Controls	Eliminate or isolate the hazard Examples: safe needle devices; rubber dam; high-volume evacuation
Work-Practice Controls	Promote safer behavior Examples: placing puncture resistant containers for disposable sharps close to where the items are used; never recap needles with both hands; pre-procedural rinses
Environmental Infection Control	Provides a safer work environment Examples: clinical contact surfaces; housekeeping surfaces; biohazard communication
Transmission-based Precautions	Prevent potential spread of specific diseases Examples: the HIV positive patient with tuberculosis
Administrative Controls	Policies targeted at reducing the risk of exposure to infectious persons Examples: work restrictions for HIV positive OHCP

likely to be effective if administered as soon after exposure as possible (ideally within two hours).

Treatment of the Exposure Site

The injured area contaminated with blood or OPIM should immediately be washed with soap and water. Exposed mucous membranes should be flushed with water. While the use of an antiseptic is not contraindicated, using an antiseptic for wound care or squeezing the wound to express fluid has not been shown to reduce the risk of infection. The application of caustic agents or the injection of antiseptics into the wound is not recommended.[49]

Exposure Report

The recording and reporting of occupational injuries and exposures should be in accordance with all federal and state requirements. When an occupational exposure occurs, the circumstances of the incident should be recorded on a form appropriate for the oral healthcare setting (Table 4).[49] Data about susceptibility, i.e., hepatitis B vaccine and vaccine response status, and HBV, HCV, and HIV immune status, may be available from the exposed person's confidential medical record and should be included in the report. Similarly, information about the source person may be available from the medical (dental) records. All of the data collected is to be carried by the exposed OHCP to the healthcare facility or physician providing the post-exposure evaluation, treatment, and follow-up.

Clinical Evaluation of the Source Person

If the HIV infectious status of the source person is unknown, he/she should be informed of the incident and tested for serologic evidence of infection.[49] If the exposure source is unknown, the likelihood of exposure to a source at high risk for infection is based on a determination of the likelihood of bloodborne pathogen infection among

Table 4. Recommendations for the content of the occupational exposure report.

Date and time of exposure:	
Details of the procedure being performed:	Identify the device used (type and brand) Describe where and how in the course of the procedure did the exposure occurred.
Detail the exposure:	Estimate the amount of blood or OPIM. Describe the severity of the exposure Percutaneous injury Depth Was blood or OPIM injected Skin or mucous membrane exposure Chapped, abraided, intact
Details about the exposure source:	HBV and HCV status HIV status Stage of disease Viral load History of antiterroviral therapy Antiretroviral resistance
Details about the exposed person:	Hepatitis B vaccination Vaccine-response status HBV, HCV, and HIV immune status
Details about post-exposure management:	Counseling Post-exposure prophylaxis Follow up

patients in the exposure setting.[49] The collection and release of HIV status information on a source person should follow all local and state laws.

Clinical Evaluation and Baseline Testing of Exposed OHCP

The consultant (the healthcare facility or physician) responsible for the post-exposure management of OHCP should determine (1) the potential for the transmission of HIV based on the type of body substance involved and the route and severity of the exposure, (2) the infectious status of the source, and (3) the susceptibility of the exposed person. OHCP potentially exposed to HIV should be evaluated within two hours after their exposure and should be tested for HIV to establish their infection status at the time of exposure.[40] If the source person is seronegative for HIV, baseline testing and further follow-up of the exposed person normally is not necessary. The likelihood of the source person being in the "window period" of HIV infection in the absence of symptoms of acute retroviral syndrome is extremely remote.[9]

Post-exposure Prophylaxis (PEP)

PEP is an important element of risk-management following occupational exposure to HIV. Recommendations for PEP apply to situations in which HCP have been exposed to a source person who has or is likely to have HIV infection. If PEP is initiated and the source person is later determined to be HIV-negative, PEP should be discontinued.

Timing and Duration of HIV PEP

PEP is to be initiated as soon as possible, preferably within two hours of exposure, and should be administered for four weeks (if tolerated).[41] This recommendation is based on evidence that following primary exposure systemic infection does not occur immediately, leaving a brief window of opportunity during which PEP might limit the proliferation of HIV in initial target cells or lymph nodes.[40] In a retrospective case-control study of HCP, PEP with zidovudine reduced the risk of HIV infection by approximately 81%.[40] However, failure of PEP to prevent HIV infection following occupational exposure has also been reported.[50-51] Failures appear to be related to higher titer and/or large inoculum exposures, delayed initiation and/or short duration of PEP, antiretroviral drug resistance, and the lack of adequate host cellular immune responsiveness.

Recommended Drug Regimens for HIV PEP

The recommended drug regimens for HIV PEP balance the risk of infection against the potential toxicities of antiretroviral drugs (Tables 5 and 6).[41] The U.S. Public Health Service recommends stratification of HIV PEP regimens based on (1) the potential for the transmission of HIV based on the type of body substance involved and the route and severity of the exposure, (2) the infectious status of the source, (3) the presence of antiretroviral drug resistance in the source, and (4) the susceptibility of the exposed person. The majority of HIV exposures are treated with a two-drug regimen, using either two NRTIs or one NRTI and one NtRTI. The usual combinations are zidovudine and lamivudine or emtricitabine; stavudine and lamivudine or emtricitabine; and tenofovir and lamivudine or emtricitabine. The addition of a third or fourth drug is recommended for high-risk exposures or when antiretroviral drug resistance is likely. The U.S. Public Health Service recommends expanded PEP be PI-based. The preferred PI is lopinavir/ritonavir. When viral resistance to PIs in the source person is known or suspected, a NNRTI is added to the PEP regimen. The use of efavirenz in women of childbearing age is cautioned because of the risk of teratogenicity.

Follow-up of OHCP Exposed to HIV

OHCP with occupational exposure to HIV should receive (1) counseling and education, (2) monitoring for PEP toxicity, and (3) post-exposure testing regardless of whether they received PEP.[41]

Counseling and Education

The emotional impact of a needlestick injury or exposure to OPIM can be substantial. Consequently, access to a counselor knowledgeable about occupational HIV transmission is a cardinal element of postexposure management. Exposed OHCP should be advised to seek medical evaluation for any acute illness during the follow-up period. Signs and symptoms such as fever, rash, myalgia, fatigue, malaise, or lymphadenopathy might be indicative of acute HIV infection. Similarly, they should be advised to avoid donating blood or tissue, breastfeeding,

Table 5. Recommended PEP for percutaneous injuries.[41]

Infection Status of Source	Less Severe Exposure (Solid needle or superficial injury)	More Severe Exposure (Large-bore hollow needle, deep puncture, visible blood on device, or needle used in patient's artery or vein)
HIV-positive Class 1 Examples: asymptomatic HIV infection or known low viral load	Recommended Basic 2-drug PEP	Recommended Expanded 3-drug PEP
HIV-positive Class 2 Examples: symptomatic HIV infection, AIDS, acute seroconversion, or known high viral load	Recommended Expanded ≥ 3-drug PEP	Recommended Expanded ≥ 3-drug PEP
Source of unknown HIV status Examples: deceased source person with no samples available for HIV testing	Generally No PEP warranted Optional Basic 2-drug PEP for source with HIV risk factors	Generally No PEP warranted Optional Basic 2-drug PEP for source with HIV risk factors
Unknown Source Examples: a needle or other sharp from an unidentifiable patient	Generally No PEP warranted Optional basic 2-drug PEP In settings in which exposure to HIV-infected persons is likely	Generally No PEP warranted Optional Basic 2-drug PEP in settings in which exposure to HIV-infected persons is likely
HIV-negative	No PEP warranted	No PEP warranted

Table 6. Recommended PEP for mucous membrane and non-intact skin exposures.[41]

Infection Status of Source	Small Volume (A few drops)	Large Volume (A major blood splash)
HIV-positive Class 1 Examples: asymptomatic HIV infection or known low viral load	Optional Basic 2-drug PEP	Recommended Expanded 2-drug PEP
HIV-positive Class 2 Examples: symptomatic HIV infection, AIDS, acute seroconversion, or known high viral load	Recommended Expanded ≥ 3-drug PEP	Recommended Expanded ≥ 3-drug PEP
Source of Unknown HIV Status Examples: deceased source person with no samples available for HIV testing	Generally No PEP warranted	Generally No PEP warranted Optional Basic 2-drug PEP for source with HIV risk factors
Unknown Source Examples: a needle or other sharp from an unidentifiable patient	Generally No PEP warranted	Generally No PEP warranted Optional Basic 2-drug PEP in settings in which exposure to HIV-infected persons is likely
HIV-negative	No PEP warranted	No PEP warranted

pregnancy, and practice sexual abstinence or condom use to prevent secondary transmission, especially during the first six to 12 weeks after exposure. Those who take PEP should be advised of the importance of completing the prescribed regimen. Information should be provided about (1) possible drug toxicities (common with all antiretroviral agents), (2) drug-drug interactions (most common with NNRTIs and PIs), (3) measures to be taken to minimize side effects, and (4) methods for clinical monitoring of toxicity.

Monitoring Patients for PEP Toxicity

If PEP is used, OHCP should have a complete blood count and renal and liver function tests done at baseline and again two weeks after starting PEP. In selected cases other tests may be required. OHCP who experience nausea, diarrhea, rash, fever, back and abdominal pain, increased thirst, or frequent urination should seek immediate medical attention.

Post-exposure Testing

After baseline testing at the time of exposure, follow-up testing should be performed at six weeks, 12 weeks, and six months to monitor for HIV seroconversion. Extended follow-up (for up to 12 months) is recommended after exposure to a source co-infected with HIV and HCV.

Work Restrictions of HIV-positive OHCP

The risk of HIV transmission in the oral healthcare setting from patients to OHCP is extremely low. Similarly, the risk of HIV transmission from OHCP to patients is also remote. The transmission of HIV by a single OHCP with AIDS has been reported, but the mode of transmission was never confirmed.[52-53] As of September 30, 1993, CDC has data on >22,000 patients of 63 HIV-infected HCP, including 34 OHCP.[53-54] In this cohort not a single case of HIV transmission from HIV-infected HCPs to patients has been documented.

The patient-care responsibilities of OHCP do not need to be modified based solely on a history of exposure to HIV. For OHCP to pose a risk of HIV transmission to a patient, they must (1) be viremic (i.e., have the HIV virus circulating in the blood stream); (2) have a condition (i.e., weeping skin lesions or other injuries) that allows direct exposure to their blood or other infectious body fluids; and (3) allow their blood or other

infectious body fluids to gain direct access to a patient's wound, traumatized tissues, mucous membranes, or similar portals of entry.[47] Clearly, even in the presence of viremia transmission cannot occur unless the second and third conditions are also met.

There are no data to indicate HIV-infected OHCP who do not perform invasive procedures pose a risk to patients. Consequently, work restrictions for these OHCP are not appropriate. However, HIV-infected HCP performing certain invasive procedures pose a risk to patients and restrictions should be imposed on these until counsel from an expert review panel has been sought according to published local and state public health regulations and recommendations for infected HCP.[55] In general, the expert panel will recommend procedures HIV-infected OHCP can perform, taking into account specific procedures as well as the skill and technique of each OHCP.

Conclusion

The risk of HIV transmission in the oral healthcare setting is extremely low. However, the emotional impact of a needlestick injury can be substantial. Consequently, OHCP must be knowledgeable about the potential risks of occupational exposure and the importance of post-exposure management strategies for those potentially exposed to HIV. Clear, written procedures related to prompt reporting, evaluation, treatment, and follow-up should promote a seamless response to an incident of occupational exposure.

References

1. Centers for Disease Control and Prevention. Pneumocystis pneumonia – Los Angeles. MMWR 1981;30:250-2.
2. Sepkowitz KA. AIDS – the first 20 years. N Engl J Med 2001;344:1764-72.
3. Pantaleo G, Graziosi C, Fauci AS. The immunopathogenesis of human immunodeficiency virus infection. N Engl J Med 1993;328:327-35.
4. Pantaleo G, Fauci AS. New concepts in the immunopathogenesis of HIV infection. Ann Rev Immunol 1995;13:487-512.
5. Centers for Disease Control and Prevention. 1993 Revised Classification System for HIV Infection and Expanded Surveillance Case Definition for AIDS Among Adolescents and Adults. MMWR 1992;41(No. RR-17):1-19.
6. WHO/EURO Report of the Technical Consultation on Clinical Staging of HIV/AIDS and HIV/AIDS Case Definitions for Surveillance. Available at: http://www.euro.who.int/document/E87956.pdf (accessed April 7, 2006).
7. Steinbrook R. The AIDS epidemic in 2004. N Engl J Med 2004;351:115-7.
8. Centers for Disease Control and Prevention. Surveillance of healthcare personnel with HIV/AIDS, as of December 2002. Available at: http://www.cdc.gov/ncidod/dhqp/bp_hiv_hp_with.html (accessed April 4, 2006).
9. Do AN, Ciesielski CA, Metler RP, Hammett TA, Li J, Fleming PL. Occupationally acquired human immunodeficiency virus (HIV) infection: national case surveillance data during 20 years of the HIV epidemic in the United States. Infect Control Hosp Epidemiol 2003;24:86-96.
10. Sepkowitz KA, Eisenberg L. Occupational deaths among healthcare workers. Emerg Infect Dis 2005;11:1003-8.
11. UNAIDS/WHO working group on global HIV / AIDS and STI surveillance. Guidelines for measuring national HIV prevalence in population-based surveys. Available at: http://www.who.int/hiv/pub/surveillance/guidelinesmeasuringpopulation.pdf (accessed April 4, 2006).
12. UNAIDS/WHO. AIDS epidemic update December 2005. Available at: http://www.who.int/hiv/epiupdate2005_en.pdf (accessed April 11, 2006).
13. Centers for Disease Control and Prevention. Trends in HIV/AIDS diagnosis – 33 states, 2001-2004. MMWR 2005;54:1149-53.
14. Kinloch-De Loës S, Hirschel BJ, Hoen B, Cooper DA, Tindall B, Carr A, Saurat JH, Clumeck N, Lazzarin A, Mathiesen L, Raffi F, Antunes F, von Overbeck J, Lüthy R, Glauser M, Hawkins D, Baumberger C, Yerly S, Perneger TV, Perrin L. A controlled trial of zidovudine in primary human immunodeficiency virus infection. N Engl J Med 1995;333:408-13.
15. Centers for Disease Control and Prevention. Revised guidelines for HIV counseling, testing, and referral and revised recommendations for HIV screening of pregnant women. MMWR 2001;50(No. RR-19):1-110.
16. Freedberg KA, Samet JH. Think HIV. Why physicians should lower their threshold for HIV testing. Arch Intern Med 1999;159:1994-2000.
17. Food and Drug Administration. Donor screening assays for infectious agents and HIV diagnostic assays. Available at: http://www.fda.gov/cber/products/testkits.htm (accessed April 10, 2006).
18. Pilcher CD, Fiscus SA, Nguyen TQ, Foust E, Wolf L, Williams D, Ashby R, O'Dowd JO, McPherson T, Stalzer B, Hightow L, Miller WC, Eron JJ Jr, Cohen MS, Leone PA. Detection of acute infections during HIV testing in North Carolina. N Engl J Med 2005;352;1873-83.
19. Sanders GD, Bayoumi AM, Sundaram V, Bilir SP, Neukermans CP, Rydzak CE, Douglass LR, Lazzeroni LC, Holodniy M, Owens DK. Cost-effectiveness of screening for HIV in the era of highly active antiretroviral therapy. N Engl J Med 2005;352:570-85.
20. Hammer SM. Management of newly diagnosed HIV infection. N Engl J Med 2005;353:1702-10.
21. Paltiel AD, Weinstein MC, Kimmel AD, Seage GR 3rd, Losina E, Zhang H, Freedberg KA, Walensky RP. Expanded screening for HIV in the United States – an analysis of cost-effectiveness. N Engl Med 2005;352;586-95.
22. Panel on Clinical Practices for the Treatment of HIV Infection, October 6, 2005, http://AIDSinfo.nih.gov. Accessed on may 1, 2006.

23. EC-Clearinghouse. Classification and diagnostic criteria for oral lesions in HIV infection. EC-Clearinghouse on Oral Problems Related to HIV Infection and WHO Collaborating Centre on Oral Manifestations of the Immunodeficiency Virus. J Oral Pathol Med 1993;22:289-91.
24. Ramírez-Amador V, Ponce-De-León S, Sierra-Madero J, Soto-Ramírez L, Esquivel-Pedraza L, Anaya-Saavedra G. Synchronous kinetics of CD4+ lymphocytes and viral load before the onset of oral candidosis and hairy leukoplakia in a cohort of Mexican HIV-infected patients. AIDS Res Hum Retroviruses 2005;21:981-90.
25. Vaseliu N, Carter AB, Kline NE, Kozinetz C, Cron SG, Matusa R, Kline MW. Longitudinal study of the prevalence and prognostic implications of oral manifestations in Romanian children infected with human immunodeficiency virus type 1. Pediatr Infect Dis 2005;24:1067-71.
26. Challacombe SJ, Coogan MM, Williams DM. Overview of the fourth international workshop on the oral manifestations of HIV infection. Oral Dis 2002;8(Suppl 2):9-14.
27. Kademani D, Glick M. Oral ulcerations in individuals infected with human immunodeficiency virus: Clinical presentations, diagnosis, management, and relevance to disease progression. Quintessence Int 1998;29:523-34.
28. Rohrmus B, Thoma-Greber EM, Bogner JR, Röcken M. Outlook in oral and cutaneous Kaposi's sarcoma. Lancet 2000;356:2160.
29. Patton LL, Phelan JA, Ramirez-Gomez FJ, Nittayananta W, Shiboski CH, Mbuguye TL. Prevalence and classification of HIV-associated oral lesions. Oral Dis 2002;8(Suppl 2):98-109.
30. Miziara ID, Filho BC, Weber R. Oral lesions in Brazilian HIV-infected children undergoing HAART. Int J Pediatr Otorhinolaryngol 2006 Jan 4; [Epub ahead of print].
31. Lawn SD, Checkley A, Wansbrough-Jones MH. Acute bilateral parotitis caused by Mycobacterium scrofulaceum: immune reconstitution disease in a patient with AIDS. Sex Transm Inf 2005;81:517-8.
32. Lipman M, Breen R. Immune reconstitution inflammatory syndrome in HIV. Cur Opin Infect Dis 2006;19:20-25.
33. Reznik DA. Oral manifestations of HIV disease. Top HIV Med 2005;13:143-8.
34. Shelburne SA, Montes M, Hamill RJ. Immune reconstitution inflammatory syndrome: more answers, more questions. J Antimicrob Chemother 2006;57:167-70.
35. Crossley ML. An investigation of dentists' knowledge, attitudes and practices towards HIV+ and patients with other blood-borne viruses in South Cheshire, UK. Br Dent J 2004;196:749-54.
36. Shirlaw PJ, Chikte U, Schmidt-Westhausen A, Croser D, Reichart P. Oral and dental care and treatment protocols for the management of HIV-infected patients. Oral Dis 2002;8(Suppl 2):136-43.
37. DePaola LG. Managing the care of patients infected with bloodborne diseases. J Am Dent Assoc 2003;134:1350-8.
38. Campo-Trampero J, Cano-Sánchez J, del Romero-Guerroro J, Moreno-López LA, Cerero-Lapiedra R, Bascones-Martínez A. Dental management of patients with human immunodeficiency virus. Quintessence Int 2003;34:515-25.
39. Puls RL, Emery S. Therapeutic vaccination against HIV: current progress and future possibilities. Clin Sci (London);2006;110:59-71.
40. Cardo DM, Culver DH, Ciesielski CA, Srivastava PU, Marcus R, Abiteboul D, Heptonstall J, Ippolito G, Lot F, McKibben PS, Bell DM. A case-control study of HIV seroconversion in health care workers after percutaneous exposure. N Engl J Med 1997;337:1485-1490.
41. Centers for Disease Control and Prevention. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HIV and recommendations for postexposure prophylaxis. MMWR 2005;54(No. RR-9):1-24.
42. Bell DM. Occupational risk of human immunodeficiency virus infection in healthcare workers: an overview. Am J Med 1997;102(suppl 5B):9-15.
43. Ippolito G, Puro V, De Carli G, Italian Study Group on Occupational Risk of HIV Infection. The risk of occupational human immunodeficiency virus in health care workers. Arch Int Med 1993;153: 1451-1458.
44. Centers for Disease Control and Prevention. Update: human immunodeficiency virus infection in healthcare workers exposed to blood of infected patients. MMWR 1987;36:285-289.

45. Fahey BJ, Koziol DE, Banks SM, Henderson DK. Frequency of nonparenteral occupational exposures to blood and body fluids before and after universal precautions training. Am J Med 1991;90:145-153.
46. Henderson DK, Fahey BJ, Willy M, Schmitt JM, Carey K, Koziol DE, Lane HC, Fedio J, Saah AJ. Risk for occupational transmission of human immunodeficiency virus type 1 (HIV-1) associated with clinical exposures: a prospective evaluation. Ann Intern Med 1990;113:740-746.
47. Centers for Disease Control and Prevention. Guidelines for infection control in dental health-care settings-2003. MMWR 2003;52(No. RR-17):1-68.
48. Department of Labor, Occupational Safety and Health Administration. 29 CFR Part 1910.1030. Occupational exposure to bloodborne pathogens; final rule. Federal Register 1991;56:64004-64182.
49. Centers for Disease Control and Prevention. Updated U.S. Public Health Service guidelines for the management of occupational exposures to HBV, HCV, and HIV and recommendations for postexposure prophylaxis. MMWR 2001;50 (No. RR-11):1-51.
50. Jochimsen EM. Failure of zidovudine postexposure prophylaxis. Am J Med 1997;102(suppl 5B): 52-55.
51. Hawkins DA, Asboe D, Barlow K, Evans B. Seroconversion to HIV-1 following a needlestick injury despite combination post-exposure prophylaxis. J Infect 2001;43:12-18.
52. Ciesielski C, Marianos D, Ou CY, Dumbaugh R, Witte J, Berkelman R, Gooch B, Myers G, Luo CC, Schochetman G. Transmission of human immunodeficiency virus in a dental practice. Ann In tern Med 1992;116:798-805.
53. Centers for Disease Control and Prevention. Investigations of patients who have been treated by HIV-infected health-care workers – United States. MMWR 1993;42:329-331, 337.
54. Robert LM, Chamberland ME, Cleveland JL, Marcus R, Gooch BF, Srivastava PU, Culver DH, Jaffe HW, Marianos DW, Panlilio AL, Bell DM. Investigation of patients of health care workers infected with HIV: the Centers for Disease Control and Prevention database. Ann Intern Med 1995;40(No, RR-8).
55. Bolyard EA, Tablan OC, Williams WW, Pearson ML, Shapiro CN, and Deitchman SD. Guideline for infection control in health care personnel, 1998. Am J Infect Cont 1998;26:289-354.

About the Authors

Michaell A. Huber, DDS

Associate Professor and Head, Division of Oral Medicine, Department of Dental Diagnostic Science, The University of Texas Health Science Center at San Antonio, Dental School, San Antonio, Texas.

e-mail: huberm@uthscsa.edu

Geza T. Terezhalmy, DDS, MA

Endowed Professor in Clinical Dentistry, The University of Texas Health Science Center at San Antonio, Dental School, San Antonio, Texas.

e-mail: terezhalmy@uthscsa.edu