Lack of HIV Transmission in the Practice of a Dentist with AIDS

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■ *Objective:* To determine whether dentist-to-patient or patient-to-patient transmission of human immunodeficiency virus (HIV) occurred in the practice of a dentist who had the acquired immunodeficiency syndrome (AIDS).

■ *Design:* Retrospective epidemiologic investigation supported by molecular virology studies.

■ *Setting:* The practice of a dentist with AIDS in an area with a high AIDS prevalence.

■ *Participants:* A dentist with AIDS, his former employees, and his former patients, including 28 patients with HIV infection.

■ *Measurements:* Identification of potential risks for acquisition of HIV infection, genetic relatedness among HIV strains, and infection-control practices.

■ *Results:* A dentist with known behavioral risks for HIV infection, who was practicing in an area of Miami, Florida, that had a high rate of reported AIDS cases, disclosed that he frequently did invasive procedures and did not always follow recommended infection-control procedures. Of 6474 patients who had records of receiving care from the dentist during his last 5 years of practice, 1279 (19.8%) were known to have been tested for HIV infection and 24 of those (1.9%) were seropositive. Four other patients with HIV infection were identified through additional case-finding activities. Of these 28 patients with HIV infection, all but 4 had potential behavioral risk factors for infection. Phylogenetic tree analysis of HIV genetic sequences from the dentist and 24 of the patients with HIV infection showed an absence of strong bootstrap support for any grouping and therefore did not indicate that the virus strains were linked.

■ *Conclusions:* Despite identifying numerous patients with HIV infection, we found no evidence of dentist-to-patient or patient-to-patient transmission of HIV during dental care. Our findings are consistent with those of all previous studies in this area, with the exception of one that did identify such transmission.

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The Florida Department of Health and Rehabilitative Services (HRS) and the Centers for Disease Control and Prevention (CDC) have previously described six patients who acquired human immunodeficiency virus (HIV) infection while receiving care from a dentist with HIV infection (1–6). To date, this dentist's practice is the only practice of a health care worker with HIV infection in which HIV transmission to patients has occurred and has been reported. The events that resulted in the infection of these patients remain unknown; however, the available evidence suggests that HIV was transmitted from dentist to patient rather than from patient to patient (7).

In July 1991, Miami newspapers published the name of another dentist who had been diagnosed with the acquired immunodeficiency syndrome (AIDS). This dentist had closed his practice 2 months earlier because of ill health. To determine whether HIV had been transmitted to patients during receipt of care in this practice, we investigated the dentist's medical history, his dental practice, and his former patients.

Methods

Epidemiologic Investigation

Information about the dentist's health was obtained from his available medical records. Because the dentist was too ill to be interviewed, information about his practice was obtained by interviewing his two former employees, a dental assistant and an office manager.

The dentist's spouse provided HRS with the names and addresses of those persons who had been patients of the dentist during the last 5 years of his practice; HRS sent a letter to each of these patients telling them that they had received care from a dentist with HIV infection and providing them with information about HIV counseling and testing services. We reviewed the available dental and medical records of all patients with HIV infection, and we interviewed all living patients infected with HIV to determine whether they had behavioral or transfusion risk factors for HIV infection.

Laboratory Investigation

We obtained a blood sample from the dentist with his consent. Blood samples were also collected from all consenting patients with HIV infection and from those of the patient's sexual partners who were known to be infected with HIV. Mononuclear cells were separated from the samples and DNA was extracted as previously described (8).

The primers MK603 and CO602 were used in a polymerase chain reaction for primary amplification of approximately 1500 nucleotides of the C1 to gp41 domain of the HIV-1 envelope gene (9). The primary amplified DNA was then diluted 50-fold and used in a nested polymerase chain reaction with the primers CL207 and CO72 to reamplify approximately 700 nucleotides of the C2 to C5 region (4). The reamplified DNA was purified by the Qiagen PCR Purification Spin Kit (Qiagen Inc., Chatsworth, California), and approximately 300 nucleotides of the V3 and

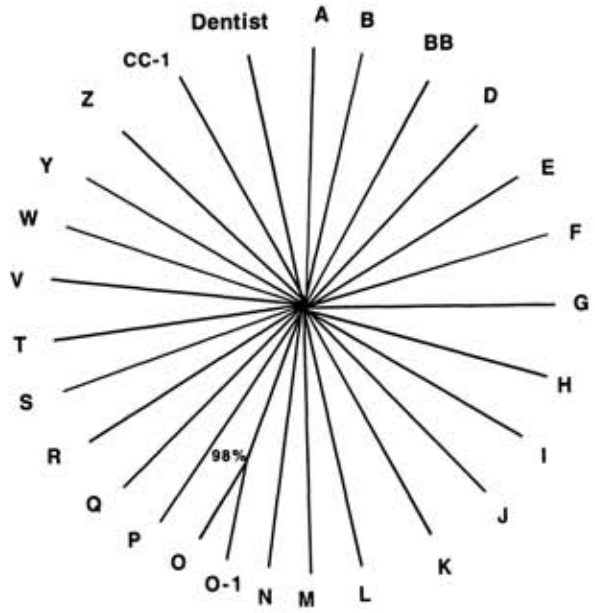

Figure 1. Unrooted phylogenetic tree illustrating the relations among HIV sequences obtained from the dentist, 24 of his former dental patients, and 2 sexual partners of patients. Genetic distance bootstrap results support only one pairing of sequences, that of O and O-1, so the other branches are shown as a "star phylogeny." Branch lengths are arbitrary.

flanking regions were sequenced in an automated DNA sequencer (Applied Biosystems Inc., Foster City, California), either directly or after being cloned into an M13 vector (4, 9).

Genetic analysis was done on direct sequences from the dentist, 21 patients, and 2 sexual partners of patients. Direct sequencing of DNA from its polymerase chain reaction product identifies the most common nucleotide at each position from all the variants present within a person. Only cloned sequences could be obtained from patients R, L, and P. A consensus sequence was generated for patients L (10 clones) and R (5 clones) based on the nucleotide present at each position in at least 50% of the clones. Because patient P had only three clones, it was difficult to generate a consensus sequence; thus, the longest, most representative clone sequence was chosen for analysis.

Sequences were aligned by hand using ESEE2.00B (10); sequence positions that could not be aligned, as well as those in which one sequence had an undetermined base, were eliminated from the analysis. Two hundred fifteen alignable positions were used in phylogenetic analysis. We calculated the number of base substitutions between each of the sequences being compared to obtain a measure of the pairwise genetic distances between the viruses of the persons studied. These distances were used to construct a phylogenetic tree. Programs from the PHYLIP suite, version 3.4, for Unix were used to construct the neighbor-joining bootstrap tree shown in Figure 1 (11). SEQBOOT was used to create 1000 subreplicate sequence files; DNADIST returned a distance matrix from each file, using a maximum-likelihood multiple-hit correction; NEIGHBOR was used to construct a neighbor-joining distance tree from each distance matrix; and CONSENSE determined the percentage of replicate trees in which each internal branch was present. This percentage, or bootstrap proportion, shows how strongly phylogenetic analysis supports a particular grouping of sequences.

Results

The dentist was a man in his 60s who had known behavioral risk factors for HIV infection and had had a positive HIV antibody test in June 1988. The reason for testing at that time is not known; the dentist had no record of an earlier negative test. In November 1989, he was asymptomatic and had a $CD4^+$ T-lymphocyte count of 206 cells/μL. By May 1990, his $CD4^+$ lymphocyte count had dropped to 69 cells/μL and therapy with zidovudine and aerosol pentamidine was started. In March 1991, he was hospitalized with pneumonia of unknown cause that responded to therapy with dapsone and trimethoprim. Human immunodeficiency virus encephalopathy was also diagnosed, although a magnetic resonance imaging scan was normal. In May 1991, the dentist was hospitalized after a syncopal episode in his office. At admission, he stated that he had retired 3 months earlier, but he apparently continued to provide care for a small number of patients. According to his medical records, his recent memory was impaired; a magnetic resonance imaging scan done at this time was normal. After he was discharged from the hospital, he closed the remainder of his practice. A month later, he was hospitalized with diagnoses of staphylococcal sepsis, anemia, and HIV encephalopathy. He died in a hospice in August 1991.

The dentist had practiced in the Liberty City area of Miami, Florida, for almost 30 years and primarily served an indigent patient population. According to his staff, he saw approximately 15 to 20 patients on a typical day and did extractions for about 5 patients per day. Since 1986 or 1987, he had routinely worn gloves, a mask, and eye protection. He recapped needles using a two-handed technique. Surgical instruments were autoclaved and other instruments, such as curettes and instruments used in restorative dentistry, were immersed in a liquid chemical germicide called Cetylcide, which is a quaternary ammonium compound (use of trade names is for identification only and does not imply endorsement by the Public Health Service or the U.S. Department of Health and Human Services). Dental handpieces were wiped with alcohol but were not autoclaved.

Single-use, disposable pieces of equipment, such as prophylaxis cups, were occasionally reused after being immersed in Cetylcide. Handpiece and dental unit water lines were not flushed. Both staff members reported that they had tested negative for HIV infection.

Of the 6474 letters sent to former patients of the dentist, 5469 (84.5%) were delivered. As a result of these letters and of newspaper articles and other media coverage about the dentist, 1279 patients were found to have been tested for HIV infection. Of these patients, 24 (1.9%) were seropositive. Additional case-finding activities identified another 4 former patients who were infected with HIV or who had AIDS. Thus, a total of 28 former dental patients with HIV infection (designated A, B, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, BB, CC, and DD) were identified.

Sixteen of the 28 infected patients (57%) were female. The patients ranged in age from 17 to 69 years (median, 35 years); 26 were African-American, 1 was Hispanic, and 1 was Caucasian. Five patients (H, U, X, CC, and DD) died of AIDS before or during the investigation.

Based on interviews with the patients and review of their medical records, we placed patients in a mutually exclusive hierarchy of potential risk categories for HIV infection (Table 1). Although none of the men acknowledged having practiced homosexual or bisexual behaviors, 19 patients had engaged in drug use or in sexual behaviors that could have resulted in HIV infection. An addi-

Table 1. Potential Risk Factors among Patients with HIV Infection in a Florida Dental Practice

Risk Factor*	Number of Patients†
Injecting drug use	3 (I, Q, R)
Heterosexual transmission‡	8 (D, H, J, O, P, S, X, CC)
Sex for drugs or money	2 (B, T)
Multiple sexual partners	6 (K, L, N, V, Y, Z)
History of sexually transmitted diseases	5 (A, E, F, M, BB)
None of above	4 (G, U W, DD)

* Mutually exclusive hierarchy.
† Identifiers are given in parentheses.
‡ Includes patients reporting sexual partners with HIV infection and patients born in countries where most HIV transmission occurs through heterosexual contact.

tional 5 patients had had one or more sexually transmitted diseases. Only 4 patients could not be placed in a potential risk category.

According to dental records, which were available for 22 patients, or self-report, all but 4 of the 28 patients infected with HIV had received care from the dentist in 1988 or later, years during which the dentist was known to have had HIV infection. During this time, 18 of the patients infected with HIV had a total of 24 invasive procedures documented in their dental records (Table 2). In most cases, the invasive procedure was extraction or alveoplasty; none of the documented procedures required the intraoral use of a dental handpiece. In March 1988, patients Z and BB had extractions done on the same day; this was the only common visit day recorded.

Blood samples were obtained from the dentist and 24 of his former patients. One of these patients, patient H, died during the investigation, after a blood sample was collected. Three other patients (X, CC, and DD) died before their blood samples could be collected. The blood sample from patient U was broken in transit and this patient died before another sample could be obtained. Samples were also taken from the sexual partners of patients O and CC (designated O-1 and CC-1, respectively); neither of these partners had been a patient of the dentist.

The mean genetic distances between the viruses of the dentist and his patients and between the viruses of the patients were 13.0% and 12.1%, respectively (Table 3), suggesting that these viral strains were not similar. The smallest genetic distance, 5.8%, occurred between the viral strains of patients K and Q; the dental visits of these patients were separated by at least 5 years. On the other hand, the viruses of patient O and her sexual partner, O-1, had a distance of 4.0%.

The results of the genetic distance analysis were consistent with those of the phylogenetic tree analysis, which indicated a lack of similar viral sequences, with the exception of the sequences from O and O-1 (Figure 1). Support for phylogenetic relatedness can be estimated by calculating bootstrap proportions (Table 3). A bootstrap proportion above 95%, such as that uniting the viral sequences of O and O-1 (97.6%), indicates strong support for linkage between the viruses. However, bootstrap proportions below 65%, which were found for all other sequences including those from patients K and Q, indicate that any similarity between these sequences may be the result of chance alone (12).

For patients X, CC, DD, and U, no blood samples were available for HIV DNA sequencing (Table 4). Patient X had an ex-husband who was infected with HIV and who was an injecting drug user. The viral strain of CC-1, a woman infected with HIV who had been a regular sexual partner of patient CC and who reported no other risk factors, differed from the viruses infecting the dentist and his patients. If we assume that she had been infected by patient CC, we may infer that patient CC was not infected by the dentist. The medical records of patient DD show that the patient's husband had had sexual contacts with prostitutes. Patient DD's death certificate indicates that she was widowed. Her dental records showed visits for construction and relining of dentures, procedures that do not involve the intraoral use of sharp instruments. Patient U died before she could be interviewed; no information about her potential risk factors for HIV infection is available. Her husband was located but failed to keep his appointment for HIV testing.

Discussion

We found no evidence for dentist-to-patient or patient-to-patient transmission of HIV infection during dental care, despite breaches in recommended infection-control practices. Although we identified 28 patients with HIV infection who had been cared for by the dentist, most of these patients had sexual or drug-related behaviors that placed them at risk for HIV infection. The identification of numerous persons infected with HIV in the practice of this dentist is not surprising because the dentist worked in an area with a high rate of reported AIDS cases (HRS. Unpublished data). Analysis of HIV nucleotide sequences from the dentist and 24 of the patients infected with HIV indicated that each was infected with a distinct viral strain. This finding was consistent with epidemiologic data suggesting that HIV transmission occurred in the community rather than in the dental practice.

We must, however, acknowledge several limitations of our study. Although the dentist cared for more than 6000 patients during the last 5 years of his practice, we ob-

Table 2. Dates on Which Invasive Procedures Were Documented in Patient Dental Records

Year	January	February	March	April	May	June	July	August	September	October	November	December
1988	T		Z, BB*		X		H	BB				
1989	E		K†			O		S	V		A, B	
1990	N, B	D					I	G	S		L	E
1991			M									

* Shared visit day.
† Patient K had three invasive procedures during March 1989.

Table 3. Human Immunodeficiency Virus Nucleotide Diversity in the V3 and Flanking Regions of the Envelope Glycoprotein gp120

Persons Compared	Interperson Variation, %	Bootstrap Proportion, %
Dentist and patients	Range, 8.0 to 17.0; mean, 13.0	<65.0
All patients	Range, 5.0 to 18.0; mean, 12.1	<65.0
Patient O and sexual partner O-1	4.0	97.6

tained HIV antibody test results for only 1279 of these patients. Other patients may have sought testing from their own physicians or may have been tested anonymously at public facilities. Given the intense publicity that accompanied this case, we believe that most dental patients with HIV infection would have been reported to HRS. However, we can exclude neither the possibility that some patients with HIV infection were not tested for HIV nor the possibility that some patients with positive test results were not reported. Additionally, we could not obtain HIV sequence data for four of the patients known to be infected with HIV, which precluded us from definitively identifying the source of their infections. However, one of these four patients had known behavioral risk factors for HIV infection, one had a sexual partner whose HIV strain was not similar to the strains infecting the dentist and other patients, and one had had no invasive dental procedures.

Nucleotide sequence analysis was a powerful tool in the study of this dental practice. Given the number of infected patients, which was larger than that reported for any other practice, this analysis was essential to the determination of whether the patients were infected while receiving dental care. Because of the high mutation rate of HIV, strains from epidemiologically unrelated persons are genetically distinct. As we reported in the study of another Florida dental practice, the presence of similar HIV sequences in different persons implies an epidemiologic relation between those persons (4). Conversely, in the present study, the lack of similar HIV sequences in the dentist and his former patients implies that these persons acquired their infections independent of one another. The only persons with similar HIV strains were patient O and her sexual partner O-1, a finding that validates our other sequencing results.

We found no evidence of patient-to-patient transmission of HIV within this dental practice, but several of the dentist's infection-control procedures, particularly his instrument reprocessing techniques, did not accord with recommended practices (13). If reusable dental instruments contaminated with the blood or tissue of patients with HIV infection are not appropriately cleaned and disinfected or sterilized between uses, HIV can be transmitted to subsequent patients. In this practice, for example, the dentist used a quaternary ammonium compound to disinfect curettes, which cut soft tissues, and other nonsurgical instruments used intraorally. Quaternary ammonium compounds are low-level disinfectants and are not recommended for use on any instrument used in the mouth (14). In addition, between patients, the dentist wiped the external surfaces of handpieces with alcohol but did not autoclave them. Handpiece and dental unit water lines were not flushed. Because the internal surfaces of handpieces may become contaminated with patient material during use, retained patient material can be expelled intraorally during use on subsequent patients (15).

Recently, investigators from Australia reported patient-to-patient transmission of HIV in the outpatient practice of a surgeon who was not infected with HIV (16). Four women were apparently infected on the same day, while having skin lesions removed; the most likely source of infection was a homosexual man who had also had a skin lesion removed on the day the women were treated. Although the precise route of transmission could not be determined, a failure of infection control most likely resulted in transmission of HIV from the man to the four women. No similar cases have been reported from the United States.

Results of this investigation and others indicate that the risk for HIV transmission from an infected health care worker to his or her patients is very small. In addition to this study, investigations involving 12 499 patients of 32 dentists and dental students infected with HIV have failed to document HIV transmission in the practice setting (17–24; CDC. Unpublished data). No HIV transmission from surgeons or obstetrician-gynecologists to patients has been reported. Nonetheless, all health care workers

Table 4. Characteristics of Patients with HIV Infection for Whom No HIV DNA Sequences Were Available*

Patient	Age, *y*	Sex	Vital Status	Number of Dental Visits (Dates)	Dental Procedures	Other HIV Risks
X	37	Female	Dead	1 (5/88)	Extraction	Heterosexual transmission
CC	30	Male	Dead	NA	NA	Multiple sexual partners, heterosexual transmission
DD	69	Female	Dead	9 (3/87–12/89)	Construction and relining of dentures	No identified risk
U	32	Female	Dead	3 (9/86–4/87)	Prophylaxis and probable extraction	No identified risk

* HIV = human immunodeficiency virus. NA = not available.

infected with HIV should be familiar with recommendations for preventing HIV transmission to patients and should follow the specific guidelines that have been implemented by their state or territorial health departments (25, 26).

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