

# HIV transmission and dental treatment

VERNON J. BRIGHTMAN DMD, PhD \*

## Introduction

The number of documented cases of HIV transmission associated with clinical procedures has been very small, and the actual risk for both health care workers (HCW) and patients is demonstrably low. While the perception of risk, rather than the actual risk, is often the determining factor in an individual's decision to indulge in or continue a risky behavior<sup>1</sup>, perception of risk to some extent can be modified by education. Continuous updating of the literature relating to documented episodes of transmission of HIV in the dental health care setting<sup>2,3</sup> hopefully may influence dental HCW to treat HIV-infected patients, and to maintain equally rigorous infection control procedures for those who are not perceived to be at risk, as well as those known to be HIV-infected. In addition, this review may help other HCW and patients to view the dental services in a better light than it is sometimes portrayed by the media.

With both HIV and hepatitis B (HBV), the virus present in blood (or other body fluids contaminated with blood, e.g., saliva generated during a dental procedure<sup>4</sup>) is considered the vehicle by which infection is usually transmitted in health care settings. The volume of the HIV-infected blood that contaminates a patient or HCW is a major factor in determining the risk infection. As a consequence, the majority of documented episodes of HIV transmission in health care settings involve patient-to-HCW transmission rather than HCW-to-patient<sup>5</sup>, except where transmission has been associated with administration of a contaminated blood product, reuse of inadequately sterilized equipment, or other nosocomial transmission<sup>6,9</sup>. It also explains why certain clinical procedures (e.g., oral surgery) carry a higher risk for bloodborne infection of HCW. The lack of contact between HCW blood and patient's tissues in most invasive procedures, versus the greater likelihood of patient's blood contacting the HCW, probably explains why episodes of transmission of both HIV and HBV from patient-to-HCW

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have been more common than vice versa<sup>5</sup>. The small volume of blood or tissue fluid likely to be inoculated during dental procedures via an accidental injury with a 27 gauge hypodermic needle, or other superficial wound or abrasion, compared with the milliliter amounts documented in some injuries incurred during general surgical and venipuncture procedures, also partly explains why there have been few reports, and no documented episodes of dental workers becoming HIV seropositive following treatment associated injuries. The usually higher concentration of HBV ( $10^5$  -  $10^9$  per ml) versus HIV ( $10^1$  -  $10^5$  per ml) in infected blood, and consequently the much smaller minimal inoculum needed to transmit HBV ( $10^3$  -  $10^4$  ml) versus HIV ( $10^1$  -  $10^2$  ml), further explain the decreased risk for transmission of HIV by contaminated needlestick injury (0.3%), as compared with

HBV (30%), which was responsible for a large number of dental HCW infections prior to the general acceptance of HBV vaccine<sup>10</sup>.

## Transmission of HIV from patient-to-HCW

Transmission of HIV from patients to HCW who experienced occupational exposure to HIV-infected blood has been documented in a number of individual case reports<sup>11-17</sup> and in the published results of several surveillance programs for occupationally acquired HIV infection<sup>18-24</sup>. To date, there appears to have been no documented report of occupationally acquired HIV infection involving dental HCW. For the purpose of surveillance programs, individual HCW are usually classified as having either documented or possible occupationally acquired HIV infection. Documented occupationally acquired infection requires evidence of HIV seroconversion (i.e., a negative HIV antibody test at the time of the exposure, that was subsequently positive) following a discrete percutaneous or mucocutaneous exposure to blood, body fluids or other clinical or laboratory specimens. Possible occupationally acquired infection is used for HIV positive HCW reporting past percutaneous or mucocutaneous occupational exposure and who lack identified behavioral or transfusion risks for HIV infection, but for whom seroconversion against HIV as a result of occupational exposure was not documented.

The United States Public Health Service Centers for Disease Control and Prevention (CDC) reported that from

\* Professor of Oral Medicine, University of Pennsylvania, School of Dental Medicine, 4019 Irving Street, Philadelphia, PA 19104, USA.

1981-1994 a total of 42 documented and 91 possible cases had been identified based upon reports of occupational exposure<sup>16, 19</sup>. No dental HCW were included among the documented cases, the majority of which involved laboratory technicians and nurses. Approximately 85% of the cases documented had percutaneous contact with HIV-infected blood or concentrated infectious HIV. The majority of the possible cases were also laboratory technicians and nurses, but 6 dental workers, as well as physicians, emergency medical technicians, health aides and maintenance workers were included in this category. By comparison with the documented cases, only 6% of possible cases had known occupational exposure to HIV. Based on surveillance of 99 occupational exposures reported to the United Kingdom Communicable Disease Surveillance Center between 1985 and 1992 and followed at least three months, a seroconversion rate of 2/99 (2%) was documented<sup>20</sup>. These 2 cases and 2 other known occupationally acquired seroconversions in the United Kingdom involved nurses and a phlebotomist, all of whom experienced needlestick injuries and seroconverted within 3 months.

Based on other surveys carried out in South Africa, USA, France and Italy<sup>20-23</sup>, the percentage of reported exposures that seroconverted has ranged from 0.31 to 5.7%. The lower figure of 0.31% (confidence interval of 0.008-1.69%) derived from a 10 year study<sup>22</sup> in which 976 HCW treating patients of the San Francisco General Hospital (patients were from an "inner city population that included a large number of intravenous drug users, gay men and others at risk for bloodborne infection") experienced a total of 327 percutaneous and 398 mucocutaneous exposures, with only one documented seroconversion. This one seroconversion involved a nurse who experienced a deep puncture with a hollow-bore needle contaminated with blood from a patient with severe AIDS. Forty of 154 dentists enrolled in the study reported exposures; while none experienced HIV seroconversion, 4 experienced HBV and 3 CMV seroconversion. No delayed HIV seroconversions (antibody not apparent at 6 months after exposure but detected later) nor seronegative latent HIV infections were observed during the mean of 1.9 years the HCW in this study were followed.

The majority of the exposures reported in this study occurred prior to the availability of zidovudine prophylaxis. While the efficacy of this post-exposure therapy has been debated<sup>21, 24, 25</sup>, the actual risk for HIV seroconversion following an occupational exposure when post-exposure prophylaxis is undertaken, is probably less than the figure of 1:300 derived from this study, which is currently often used as a

measure of the actual risk of seroconversion from a percutaneous exposure to HIV-infected blood. Since no seroconversions were documented following mucocutaneous exposure, the actual risk of seroconversion following such an event has not been estimated. One documented case of seroconversion following mucous membrane contamination was reported in the Italian Multicenter Study<sup>23</sup>; the 0.09% risk calculated from this event is considered to be possibly an over estimate of the risk of seroconversion from mucocutaneous exposure.

Similarly, since no occupational transmission of HIV to a dental worker has been documented in any of these prospective studies, the actual risk for dental workers is unknown. However, it is presumably less than the 1:300 figure. The very small amount of patient's blood associated

with dental needlestick injuries further minimizes the risk, although superficial as well as deeply penetrating wounds have been incriminated as the route of occupationally acquired HIV infection<sup>14</sup>. Post-exposure debridement and zidovudine prophylaxis are strongly recommended for

any penetrating injuries incurred in the course of dental as well as general surgical treatment of known HIV positive patients<sup>24</sup>.

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## Transmission of HIV from infected HCW-to-patient

**HIV-infected HCW and HCW with AIDS:** In the USA by early 1991, over 6400 HCW with AIDS (4.8% of all adult cases) had been reported to CDC, over 94% reported non-occupational risks for acquiring the infection. One hundred and seventy one (2.7%) were dental personnel<sup>26</sup>; 70% were known to have died at the time of the report. Since HIV infection is not a reportable disease in many countries, and compulsory HIV antibody testing of HCW has not been widely implemented<sup>27-29</sup>, estimates of the number of HIV-infected HCW for the most part have been based on self-selected groups of HCW, who might not be representative of the full spectrum of health care practice in a particular speciality or community. For example, only 4 HIV positive sera (believed to be from the same individual) were identified among specimens drawn from 12 465 dentists who volunteered for anonymous testing at the annual meetings of the American Dental Association from 1986 to 1994, for a prevalence rate of <0.01%, versus 0.025% for the general public<sup>30</sup>. Similar surveys of groups of orthopedic surgeons and dentists in the USA and other countries<sup>31-33</sup>, as well as employees in several African hospitals treating large numbers of HIV-infected patients<sup>34</sup>, also demonstrated either no evidence of HIV-infected

Table 1. Retrospective (look-back) studies of patients treated by HIV-1 positive physicians and dentists 1985-1994 \*

Source	Year of report	HIV positive proband's specialty	Patients evaluated / patients at risk	Patients HIV positive	Patients HIV positive without risk factor	Was molecular analysis of HIV strains performed?	Comments
<b>CDC surveillance</b>							
CDC	1993	7 HCW	46 HCW-11,529/2 11HCW-7,507/?	0 92	- 5	- YES	No molecular homology detected between these 11 HCW and their HIV + patient's DNA
<b>Case reports of physicians and surgeons</b>							
Sacks	1985-86	Urology	0/400 (0%)	-	-	-	No HIV antibody testing
Armstrong, Miner, Wolfe	1987	General surgery	75/1804 (4%)	-	-	-	Limited HIV antibody testing.
Porter et al	1990	Orthopedics and general surgery	76/339 (22%)	0	-	-	Limited follow-up
Mishu et al.	1990	General surgery	616/2160 (29%)	1	-	NO	Limited follow-up
Danila et al.	1991	Family practice and obstetrics	325/336 (97%)	0	-	-	Non-invasive contact
Von Reyn et al.	1993	Orthopedic surgery (New Hampshire) 1978-1991	1174/2317 (51%)	0	-	-	-
Rogers et al	1993	General surgery (Maryland)	514/1131 (45%)	1	0	YES	HIV + patient was probably infected via blood transfusion.
Babinchak & Renner	1994	Cardiothoracic surgery	189/612 (31%)	-	-	-	-
<b>Case reports of dental personnel</b>							
Comer et al.	1991-92	Dental student	154/163 (94%)	0	-	-	-
Dickinson et al.	1993	Veterans Administration dentist (Florida)	900/1,048 (86%)	5	1	YES	HIV + patients without risk factors were infected with virus strain unrelated to dentist's
York and Arthur	1993	3 US Navy dentists	2,039/2,887 (70%)	3	0	NO	Extensive Navy treatment records and data files greatly enhanced investigation
CDC and others	1990-94	The 1990 Florida Dental Investigation	1100/?	9	6	YES	See text for further details
Longfeld et al.	1994	Pediatric dentist	1,631/2,753 (59%)	0	-	NO	42% patients had only low-risk exposure. Dentist Stage 1 HIV infection
Jaffe et al.	1994	Second Florida dentist	1,279/6,474 (20%)	28	4	YES	No evidence for linkage of dentist's & patient's HIV strains

\* Adapted from Brightman VJ2: q.v. references for individual reports through 1993

clinicians, or no greater frequency of HIV infection among clinical versus non-clinical personnel and the community at large.

Routine surveillance of HIV infection among US Army active duty and reserve personnel revealed a prevalence of 0.09% for physicians and dentists, similar to that of 0.15% for non-medical personnel<sup>27</sup>. A recent study of HCW who donate blood, as a sentinel group for HIV infection attributable to occupational exposure also estimated the overall prevalence of HIV among HCW to be 0.04 to 0.07%<sup>28</sup>. These more recent data, and those from earlier surveys clearly indicate that an HCW per se is no more likely to be HIV positive than any other member of the public, and that HIV infection attributable to occupational exposure is uncommon.

**Surveys of patients treated by HIV-infected HCW:** Only one HIV positive HCW (a private dental practitioner in Florida USA) has been linked to transmission of HIV to patients (a single cluster of 6 patients). This case apart, the CDC as of May 1993 had accumulated data on the HIV antibody status of some 19 039 patients treated by 57 HIV-infected HCW (see Table I for details of published surveys). No HIV seropositive specimens were identified among the 11 529 patients treated by 46 of these HCW (including 23 dentists and dental students); and among 92 seropositive specimens obtained from the 7507 patients treated by the remaining 11 HIV seropositive HCW (including 6 dentists), only 5 patients lacked evidence for their having acquired HIV infection by another route. A comparison of the molecular sequences of viral DNA obtained from 29 of these patients and the matched HCW revealed no evidence to identify a HCW as the source of any of these patients' infections.

Table 1 also lists some 14 retrospective ("look back") studies of patients treated by HIV seropositive physicians, surgeons and dentists that were carried out to assess the risk of HIV transmission by an infected HCW, and published as individual reports between 1985 and 1994<sup>2,3,6,40</sup>; some of these are also included in the CDC review. While the rigour of these studies increased significantly over time, they all failed to identify any patient infected as a consequence of treatment by a HIV-infected clinician. In several studies, over 1000 patients treated by individual HIV infected physicians or dentists (representing as many as 86% of

those at risk) were tested for HIV antibody; in some reports, the patients tested were limited to those who had undergone invasive procedures, and where HIV positive patients were identified, molecular analysis of HIV strains from patient and practitioner was used to eliminate the possibility of HCW-to-patient transmission. Based on these data, it is apparent that HCW-to-patient transmission must be very rare. However, since many patients were not available for follow-up testing, the level of risk cannot be measured accurately by this approach. On the assumption that HCW-to-patient HIV transmission occurs by the same route, and in similar settings as those in which HBV transmission has been confirmed, the risk of HCW-to-patient transmission of HIV has been estimated at between 1 per 100 000 to 1 per million patient contacts<sup>41-43</sup>. Consequently, the likelihood that any "look back" investigation based on an individual HIV positive HCW's clinical contacts will identify transmission, is very low. It has been suggested that more cases of HCW-to-patient transmission and more accurate data on

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this risk, might be obtained by rigorous investigation for a history of surgery or dental treatment by an HIV-infected provider, whenever newly infected HIV patients who lack other identified risk factors are diagnosed<sup>43</sup>. The fact that the one recognized incident of HIV transmission from an infected HCW to a cluster of patients was identified in this fashion further emphasises the need for this approach, difficult as it may be, given the problems associated with compulsory HIV testing of HCWs<sup>27,30</sup>.

**HCW-to-patient transmission attributed to a Florida dentist:** In the case of the Florida dentist who died of AIDS in 1990, and who has been linked to the transmission of HIV to 6 of his patients as a result of extensive investigations coordinated by the CDC [*"The 1990 Florida Dental Investigation"*]<sup>2,37,44</sup>, the exact mode of transmission remains unknown, partly due to the paucity of available treatment records. However, these patients' HIV infections are believed to be related to treatment by this dentist, due to the clustering of cases, the absence of other known contact between the dentist and the 6 HIV positive patients, and the genetic relatedness of the HIV strains from the dentist and his infected patients. Of about 1100 of his patients tested, 9 were found to be seropositive. Six are identified as having acquired their infection during treatment by the dentist, based upon the following evidence: all had no other confirmed exposures to HIV; all had invasive procedures performed by the dentist (extractions and endodontic

treatment in 5, and dental prophylaxis, restorations and local anesthetic injection in the sixth); DNA nucleotide analyses of the dentist's and 6 patients' strains of HIV were similar, and genetically distinct from the strains isolated from another 3 seropositive patients, and from 35 HIV infected individuals residing in the area who were not patients of the dentist (all 38 positive controls tested had known risk factors for HIV infection).

While there has been scientific controversy concerning the results of these molecular analyses of the viral genome utilized in the CDC's investigation of this cluster of HCW-transmitted HIV infection, transmission by this route is also supported by the failure of additional epidemiologic investigations of this cluster to find any evidence of patient-to-patient transmission of these strains; either through contact outside of the dental office or through the reuse of instruments contaminated with blood or saliva from an HIV-infected patient without prior cleaning and sterilization<sup>45</sup>.

In the initial genetic analysis of these HIV strains carried out by the CDC<sup>46</sup>, genomic fragments were isolated from some 43 blood specimens (dentist, 7 patients and 35 HIV positive controls). Those from the dentist, the 7 patients and 4 controls were subjected to computerized phylogenetic tree (cluster) analysis, using a statistical approach referred to as a parsimony algorithm. One year later, the conclusions of this analysis were challenged by a group of investigators experienced with the use of phylogenetic tree analysis of retroviral strains<sup>47</sup>. For this second investigation, another set of DNA genomic sequences were prepared from the dental patients, and from a new set of 10 HIV positive local controls. Using an improved statistical model for investigating cluster relationships (threshold parsimony analysis), they found that the control patient sequences were more similar to the sequences from the patients; and on the basis of this comparison and other data, they concluded that their analyses could not distinguish between the dentist-to-patient hypothesis versus the null hypothesis that the dental patients independently acquired their HIV infection in the local community. Less readily confirmable information regarding the possibility that one or more of the HIV infected dental patients (who had been accepted in the CDC investigation as having no other possible risk factors for HIV infection), may indeed have had other opportunities for HIV infection in the community, were published in *Lear's Magazine* (a US consumer magazine for women) and the *New York Times*<sup>48,49</sup>, and debated in the media.

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By the end of 1994, however, these scientific and lay challenges to the conclusion that the dental patients' HIV infections in this cluster were acquired from the dentist, were laid to rest by publication of a third genetic analysis of the dentist's, patients' and the original and additional control patients' HIV genomic fragments<sup>50,51</sup>; and by a detailed rebuttal by the CDC of the allegations regarding possible high risk contacts by the HIV-infected dental patients outside of the dentist's office, that had been raised in these publications and in civil proceedings relating to this episode<sup>52</sup>. The third genetic analysis<sup>49,50</sup> concentrated on comparison of genomic fragments from individual HIV-infected dental patients and from the dentist, rather than data combined from the group of 5 dental patients used in the first two investigations (“majority rule consensus” approach), and established convincingly that the genomic analysis of 6 of the patients versus the dentist's were consistent with the dental transmission hypothesis.

**Other nosocomial transmission of HIV to patients:** Nosocomial transmission (HIV infection acquired in a hospital or other health care setting, irrespective of whether the HCW involved in the patient's care were HIV positive or not) has been documented on many occasions. The majority of these episodes have involved parenteral injection of HIV contaminated fluids. For example, patients who received HIV-infected blood transfusions or other blood products, prior to obligatory testing of all transfused fluids and transplanted organs in 1985<sup>53</sup>, as well as those who subsequent to this precaution have received blood from a recently HIV-infected donor who was seronegative at the time of the donation<sup>9</sup>, qualify as nosocomial transmission. Similarly, many instances of transmission of HIV through repeated use of syringes or other surgical instruments without sterilization between patients, use of multiple dose vials of anesthetic, vaccine etc, or lack of other standard infection control procedures have been documented in the literature<sup>6, 8</sup>. Despite rigorous clinical protocols, mistakes still sometimes occur, as for example when patients in a nuclear medicine clinic in the USA were injected with radiolabelled blood from the wrong patient, in this case a HIV positive individual<sup>7</sup>.

By comparison with the number of “look back” investigations of patients treated by HIV-infected clinicians that have been reported in the literature, there are fewer reports of nosocomial transmission, even though the number of patients who have acquired HIV infection as a result of imperfect infection control procedures or other mistakes is by no means small. Using bacterial contamination and

blood as surrogate markers for HIV transmission via insufficiently sterilized syringes used under field conditions in Africa (and many other countries), Hoelscher *et al.* concluded that less than 0.4% of HIV transmission occurred by this route each year in the area of Tanzania investigated<sup>6</sup>. However, in this area with high HIV prevalence, this amounts to 200 to 300 new infections annually by this route. Moreover, closer attention to universal precautions has been demonstrated to eliminate nosocomial transmission, even in situations where multiple transmissions had once occurred by this route<sup>6</sup>. The need for greater emphasis on strict universal precautions worldwide, and on an adequate supply of disposable syringes and other surgical equipment, gloves and autoclaves in countries with limited health expenditure, is obvious, and must be addressed in each nation's AIDS program<sup>54</sup>.

Recent reports from the USA and Australia of nosocomial transmission of HIV in the absence of a known HIV-infected HCW<sup>55,56</sup> also draw attention to the likelihood that even minor and unrecognized breaches of infection control can be responsible for nosocomial transmission, and will be considered the HCW's responsibility even when the actual route of transmission has not been identified<sup>57</sup>. The likelihood of nosocomial transmission of HIV will remain, even in countries like the USA<sup>58</sup> and Germany<sup>59</sup>, as long as imperfect infection control and screening practices continue. With each new report of nosocomial transmission of HIV, the need for routine HIV antibody testing of HCW is also likely to be re-emphasized<sup>60</sup>, regardless of whether an HIV-infected HCW is involved or not.

## Conclusions

While the likelihood that a HCW will acquire HIV infection as a consequence of providing treatment for a HIV-infected patient is quite low, over 50 cases have been reported in the USA, United Kingdom, France, Italy and South Africa, in which a HCW has been documented as having acquired HIV infection following a needlestick or other injury involving a HIV-infected patient. Most of these episodes involved deeply penetrating injuries and/or injuries with hollow-bore needles previously used to withdraw patient's blood. In one case, transmission occurred following mucous membrane contamination with a large quantity of blood from a HIV positive hemophilic patient. No cases have been documented involving dental personnel.

Based upon several follow-up studies of HCW who experienced needlestick injuries involving HIV-infected patients, the risk for seroconversion as a result of such injuries has been calculated as approximately 1/300. Post-injury

zidovudine prophylaxis may decrease the risk even further. Even if a clinical practice includes known HIV positive patients, HCW per se are no more likely to be HIV infected than other members of the community in which they practice.

The risk of HCW-to-patient transmission of HIV has been estimated to be approximately one per million patient contacts, but there are no hard data to confirm this estimate. Retrospective ("look back") investigations of over 20 000 patients treated by more than 60 HIV positive physicians, surgeons and dentists have failed to identify any HIV infected patients in whom infection can be linked to the infected HCW.

Extensive investigations of the patients treated by one HIV-infected dentist, that were triggered by the diagnosis of AIDS without other known risk factors in a patient treated by the dentist, revealed a total of 6 patients of this dentist with HIV infection associated with strains of HIV genetically related to the dentist's HIV strains. Following considerable scientific and lay controversy concerning the source of these infections, the data obtained in this CDC "1990 Florida Dental Investigation" appear to be consistent with HIV transmission from the infected dentist to these patients. The actual route of transmission remains unknown, however.

Future epidemiologic investigation of the possibility of a history of surgery or dental treatment by an HIV-infected HCW whenever newly infected HIV patients who lack other risk factors are diagnosed, may reveal other episodes of HCW-to-patient HIV transmission. However, all available data suggest that HCW-to-patient and nosocomial transmission in general are rare, unless universal precautions are not followed or HIV contaminated blood or other fluids are injected inadvertently.

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**“ The risk of HCW-to-patient transmission of HIV has been estimated to be approximately one per million patient contacts, but there are no hard data to confirm this estimate. ”**

**“ Worldwide the human rights of HIV infected people or people with AIDS are routinely abused by governments and individuals alike. In addition to the epidemic of HIV/AIDS we face an epidemic of prejudice ... ”**

**Dr Dorothy Blake, Deputy Director, WHO Global Programme on AIDS.**