Ling Li,[1] M.D.; Xiang Zhang,[2] M.D.; Niel T. Constantine,[2] Ph.D.; and John E. Smialek,[1] M.D.

Seroprevalence of Parenterally Transmitted Viruses (HIV-1, HBV, HCV, and HTLV-I/II) in Forensic Autopsy Cases

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ABSTRACT: HIV, HBV, HCV, and HTLV show similar modes of transmission and infection is frequently identified in certain population groups. The seroprevalence of these infectious agents and interrelation in forensic autopsy populations are described here.

A total of 414 serum samples were collected sequentially from autopsy cases at the Office of the Chief Medical Examiner for the State of Maryland. All samples were tested for the presence of antibodies to HIV-1, HCV, HTLV-I/II, and hepatitis B core antigen, using Enzyme-linked Immunosorbent Assays (ELISA). Samples yielding repeatedly reactive results were confirmed by Western Blots (WB) for HIV-1 and HTLV-I/II, while for HCV confirmation, the second generation recombinant immunoblot (RIBA-2) was used.

Of the 414 cases, 32.6% (135/414) were infected with at least one of the four viruses. 5.6% were seropositive for HIV-1, 23.2% for HBV, 19.1% for HCV, and 1.0% for HTLV-I/II. Intravenous drug users (IVDU) showed significant increased prevalences of HIV-1, HBV, and HCV. 83.6% of the IVDU were infected with at least one of the three viruses, 25.5% with HIV-1, and 47.3% with both HBV and HCV.

The data indicate that the overall prevalence of HIV, HBV, and HCV seropositivity in the autopsy population of an inner city medical examiner office is much higher than that of the general population. Routine testing only for HIV-1 would have missed 86% of the infections with HCV or HBV. Universal precautions should be strictly employed by all personnel working in this environment.

KEYWORDS: pathology and biology, seroprevalence, HIV-1, HBV, HCV, HTLV-I/II, autopsy, occupational risk

Many infectious agents can be transmitted through infected blood or blood contaminated biomaterial and human body fluids. In addition to human immunodeficiency virus type 1 (HIV-1), Hepatitis B virus (HBV) and hepatitis C virus (HCV) are major sources of public health concern because they share similar modes of transmission and are relatively prevalent among certain population groups [*1–4*]. In the United States, there

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[1]Research Associate and Associate Professor, respectively, Office of the Chief Medical Examiner, State of Maryland, Baltimore, MD.

[2]Research Fellow, Director of Clinical Immunology, and Associate Professor, respectively, University of Maryland School of Medicine, Baltimore, MD.

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have already been > 100 000 deaths attributable to AIDS, and there are an estimated 1.5 million Americans infected with HIV who are still asymptomatic [5]. An estimated 200 000 to 300 000 new cases of hepatitis B infections were recorded annually between 1980 and 1991 in the U.S. and there are about one million persons with chronic HBV infection [6]. HCV is considered to be the chief etiologic agent for non-A, non-B hepatitis and is prevalent among blood transfusion recipients [7–9]. It is currently estimated that approximately 150 000 to 170 000 HCV infections occur annually in the United States [10]. Human T-cell lymphotropic virus type I/II (HTLV-I/II) which is associated with adult T cell leukemia and tropical spastic paraparesis is also prevalent among blood transfusion recipients and drug users [11]. Although their seroprevalence and interrelationship in a general population of patients have just been addressed, there are very limited data to show the phenomena in some special populations. Because parenteral transmission appears relatively efficient for these viruses, percutaneous exposure represents an occupational risk to health care providers. As health care providers commonly have contact with patient's blood or body fluids during routine work, it can be expected that health care professionals are at increased risk of exposure and infection with many infectious diseases, especially HIV, HBV, and HCV. Routine testing of patients for HIV-1 has recently been advocated as a means of increasing provider vigilance and reducing occupational exposures [12]. However, a strict focus on routine HIV-1 testing may not identify patients with other transmissible blood-borne infections, such as HBV and HCV.

HIV-1, HBV, HCV, and HTLV-I/II share modes of transmission and are relatively prevalent among certain population groups. However, their seroprevalence and interrelations in forensic autopsy cases have not been adequately described. Because of the potential exposure of police, fire fighters, emergency medical personnel and the staff of medical examiner offices to biological fluids of deceased persons, it is useful to characterize the epidemiological profile of HIV, HBV, HCV, and HTLV infections in the autopsy population.

In this study, we tested 414 forensic autopsy cases for antibodies to HIV-1, HCV, HBV, and HTLV-I/II. Our objective was to identify the seroprevalence and interrelations of these viruses in an inner-city forensic autopsy population, and to analyze the risk factors related to these infections.

Materials and Methods

Subjects

A total of 414 blood specimens were collected in a sequential manner from cases autopsied at the Office of the Chief Medical Examiner, State of Maryland between February and April 1992, via cardiac puncture at the time of autopsy. Following centrifugation at 2500 rpm for 10 minutes at ambient temperature, the sera were recovered and stored frozen at −20°C until testing. About 10% of the samples were slightly hemolyzed. The time of post-mortem collection ranged from 8 to 30 hours. All samples were coded and tested blindly in order that the identity of the individual was unknown.

Data concerning demographics, manner of death, and risk factors were collected for each case. The individuals ranged in age from 1 to 85, yield mean age of 39, and 76.6% were male, 23.4% female, 53.6% were white, 45.4% were black, with 1.0% of other racial origin. Information on risk factors included a history within the past 10 years of intravenous drug use (IVDU), and homosexual or bisexual activity, or if risk factors were unknown, cases were classified as unknown.

Serologic Testing

Serum samples were tested retrospectively for the presence of antibodies to HIV-1, HBV, HCV, and HTLV-I/II. All testing was performed according to the protocols sup-

plied by the manufacturers. Antibodies to HIV were detected using an FDA-licensed ELISA (HIV-AB HIV-1/2, rDNA, Abbott Laboratories, Chicago, IL.) and repeatedly reactive samples were further confirmed by Western blot (WB) (BioRad, Hercules, CA.). Criteria for positivity by WB for HIV-1 were reactivity to any two of p24, gp41, or gp120/160, as recommended by ASTPHLD/CDC. Antibodies to HTLV-I/II were screened and confirmed by ELISA and WB respectively, (Cambridge Biotech, Worcester, MA.). The criterion for a positive reaction was reactivity to at least the core p24 and rgp21 as recommended by the manufacturer. For testing hepatitis C virus antibodies, the second generation recombinant viral antigen-based bead ELISA (Abbott Laboratories) was used for screening, with repeatedly reactive specimens confirmed using a second generation recombinant immunoblot assay (RIBA, Chiron Corp., Emeryville, CA.). Finally, hepatitis B core antibodies (anti-HBc) were detected using ELISA (Corzyme, Abbott laboratories) and all the reactive samples were repeated at least once in duplicate to be considered as anti-HBc confirmed positive.

Statistic Analysis

Statistical comparisons of the results were made using the Chi-Square test for proportions. Seroprevalence rates related to age, race, and manner of death were calculated for each category and the ages were grouped in 10-year intervals. The criterion of significant difference was $P < 0.05$.

Results

Of 414 autopsy cases tested, 135 (32.6%) had serologic evidence of at least one viral marker. There were 23 serum samples positive for HIV-1 (5.6%), 96 positive for anti-HBc (23.2%), 79 for HCV (19.1%), and 4 positive for HTLV-I/II (1.0%). The seroprevalence of HIV-1, HBV, HCV, and HTLV-I/II in the different groups is shown in Table 1. Increased seroprevalence rates of HIV-1, HBV and HCV were found in men, blacks, victims of homicide, and IVDU related cases of death.

The prevalence of HIV-1 infection in both male and female was similar in this population, male 5.7%, and female 5.2%. There was no significant difference in HBV infection by sex. The incidence of HCV infection in males was at least two times higher than that of females (21.8% to 10.3%). As for the incidence of HIV-1, HBV, HCV, and

TABLE 1—*Demographic characteristics of autopsy cases and seroprevalence of each virus in different groups.*

	Sample Population (%)	HIV-1 (%)	HBV (%)	HCV (%)	HTLVI/II (%)
Sex					
Male	317 (76.6)	18 (5.7)	77 (24.3)	69 (21.8)	4 (1.3)
Female	97 (23.4)	5 (5.2)	19 (19.6)	10 (10.3)	0 (0)
Race					
Black	188 (45.4)	19 (10.1)	53 (28.2)	41 (21.8)	4 (2.1)
White	222 (53.6)	4 (1.8)	42 (18.9)	38 (17.1)	0 (0)
Others	4 (1.0)	0 (0)	1 (25.0)	0 (0)	0 (0)
Manner of Death					
Natural	154 (37.2)	7 (4.6)	31 (20.1)	17 (11.0)	2 (1.3)
Accident	78 (18.8)	0 (0)	4 (5.1)	13 (16.7)	1 (1.3)
Homicide	75 (18.1)	5 (6.7)	16 (21.3)	16 (21.3)	0 (0)
Suicide	57 (13.8)	1 (1.8)	4 (7.0)	3 (5.3)	0 (0)
Undetermined[a]	50 (12.1)	10 (20.0)	31 (62.0)	30 (60.0)	1 (2.0)
Total	414	23 (5.6)	96 (23.2)	79 (19.1)	4 (1.0)

[a]92% (46/50) cases were drug-related.

HTLV-I/II infections by different race, there was no significant difference except with HIV-1, where the incidence in blacks was 10.1%, and 1.8% in whites.

The seroprevalence of HIV-1, HBV, HCV, and HTLV-I/II by different ages is shown in Table 2. The highest rate for HIV-1 (11.4%) was among the 30–39 years of age group. The prevalence of HBV infection did not vary significantly with age, although the rate was somewhat higher among cases between 30–39 years old. HCV infection showed a significantly higher seroprevalence rate in the group of 30–49 years old than in the remainder of the population. There were only 4 confirmed positive cases of HTLV-I/II infection.

The seroprevalence of HIV-1, HBV, HCV, and HTLV-I/II in IVDU groups was significantly higher than in individuals not having risk factors. 46/55 (83.6%) IVDU were infected with at least one of the viruses. Relatively high rates of infection were also found among those whose only acknowledged risk factor was homosexuality. The details of risk factors related to the prevalence of the four virus infection are shown in Table 3.

Of the 75 homicide cases, 61/75 (81.3%) were blacks, 56/75 (74.7%) were in the age of 30–49, and 59/75 (78.7%) were males. Of the 50 cases with an undetermined manner of death cases, 46/50 (92%) were intravenous drug users.

Data on the coincidence of infections with HIV-1, HBV, and HCV are given in Tables 4, 5, 6. Out of the 414 autopsy cases 23 were HIV-1 positive, of which 13 also had HBV infection, yielding 56.5% of the HIV-1 positive individuals co-infected with HBV. Eleven

TABLE 2—*Distribution of seropositive cases by age.*

Age (year)	Population (%)	HIV-1 (%)	HBV (%)	HCV (%)	HTLV-I/II (%)
<19	42 (10.2)	0 (0)	5 (11.9)	1 (2.4)	0 (0)
20–29	86 (20.8)	4 (4.7)	14 (16.3)	12 (14.0)	0 (0)
30–39	105 (25.4)	12 (11.4)[a]	32 (30.5)	41 (39.1)[a]	1 (0.9)
40–49	82 (19.8)	4 (4.9)	22 (26.8)	20 (24.4)[a]	0 (0)
50–59	37 (8.9)	3 (8.1)	7 (18.9)	3 (8.1)	1 (2.7)
>60	62 (15.0)	0 (0)	16 (25.8)	2 (3.2)	2 (3.2)
Total	414	23	96	79	4

[a]Statistically significant difference ($P < 0.05$), Chi-square test.

TABLE 3—*Seroprevalence of antibody positives for HIV-1, HBV, HCV, and HTLV-I/II by high-risk factors.*

Risk factors	Population (%)	HIV-1 (%)	HBV (%)	HCV (%)	HTLV (%)
IVDU	55 (13.3)	14 (25.5)	36 (65.5)	34 (61.8)	2 (3.6)
Homosexual	3 (0.7)	2 (66.7)	1 (33.3)	2 (66.7)	0 (0)
Unknown	356 (86.0)	7 (2.0)	59 (16.6)	44 (12.4)	2 (0.6)

TABLE 4—*Correlation between anti-HIV and anti-HBV.*

	Anti-HIV + (%)	Anti-HIV − (%)	Total
Anti-HBc +	13 (13.5)	83 (86.5)	96
Anti-HBc −	10 (3.1)[a]	308 (96.9)	318
Total	23	391	414

[a]$P < 0.001$, Chi-square test.

TABLE 5—*Correlation between anti-HIV and anti-HCV.*

	Anti-HIV + (%)	Anti-HIV − (%)	Total
Anti-HCV +	11 (13.9)	68 (86.1)	79
Anti-HCV −	12 (3.6)[a]	323 (96.4)	335
Total	23	391	414

[a]$P < 0.001$.

TABLE 6—*Correlation between anti-HCV and anti-HBc.*

	Anti-HCV + (%)	Anti-HCV − (%)	Total
Anti-HBc +	48 (50.0)	48 (50.0)	96
Anti-HBc −	31 (9.7)[a]	287 (90.3)	318
Total	79	335	414

[a]$P < 0.001$.

of HIV-1 positive cases were also HCV infected, yielding a co-infection rate of 47.8%. Ten of the HIV-1 positive cases had both HBV and HCV infections, which yielded a triple infection rate of 43.5%. Eight of the ten triple infections were related to IVDU or homosexuality.

Seventy-nine of the cases showed anti-HCV positivity, with 48 being positive for anti-HBV (60.8%). The Chi-Square tests confirmed the impression that co-infections with the viruses HIV-1 + HBV, HIV-1 + HCV, and HCV + HBV occurred with statistical significance.

Routine testing only for HIV-1 would have missed 86 percent of the infections with HCV or HBV to which forensic pathologists and other health care workers were exposed in this study.

Discussion

The epidemiologic and laboratory investigation of the transmission of human immunodeficiency virus (HIV) from an infected dentist to five patients presents us with serious questions [*13*]. What is the risk of transmission of HIV from patient to health care workers? How can this risk be quantified, or at best, characterized and how might this risk be reduced?

For transmission of HIV, HBV, HCV, and HTLV, blood is the single most important source of infection. Data have proved that exposure to blood through the percutaneous route is significantly more likely to transmit blood-borne viruses than is mucous membrane or cutaneous contact. For a health care worker, the average risk for HIV infection after a percutaneous needlestick injury with HIV-infected blood is estimated to be 0.3% [*14*]. Obviously, health care workers are more likely than patients to experience contact with blood in the health care setting, so, the risk for transmission of blood-borne viruses from patient to health care worker clearly exceeds that of health care worker to patient [*15*]. One particular aspect regarding the risk of transmission of infectious diseases in a medical examiner office is that there is only one way of transmission requiring our attention, that from subject to pathologists and assistants or any other personnel who are involved in the autopsy process. So far, there is no documented case report of HIV transmission to

health care workers in medical examiner facilities. However, the Centers for Disease Control (CDC) have reported 32 health care workers in the United States with documented occupationally acquired HIV infection and 69 with possible occupationally acquired HIV infection [*16*]. As for HBV, CDC estimates that there are at least over 12 000 cases of health care workers annually acquiring HBV infection in the workplace [*17*].

The testing of postmortem sera for antibodies to HIV has been shown to be a reliable and accurate measure of antemortem HIV infection. Antibodies to HIV have been shown to remain detectable in postmortem serum stored for relatively long periods of time, >60 days at 4°C and up to 176 days at −70°C, without degradation [*18*]. Furthermore, it has been demonstrated that extensive hemolysis of cadaveric blood does not interfere with ELISA or Western blot analysis of HIV seropositivity [*18*]. In general, proteins such as the globulins that comprise antibodies may not be affected by postmortem decomposition, hemolysis, or bacterial contamination [*19*]. We have showed successfully before of determination of antibodies to HCV in either serum or urine samples from postmortem cases [*20*]. Since HIV and HCV antibodies have been successfully detected in postmortem sera, it is reasonable to predict that the antibodies to HBV and HTLV should be easy to be detected in postmortem sera if they do have it.

In this study, we attempted to determine the prevalence of antemortem HIV-1, HBV, HCV, and HTLV-I/II infections in the forensic autopsy population seen at the Office of the Chief Medical Examiner State of Maryland (OCME). During the period of February to April, 1992, 2053 cases were received by OCME. Of the 2053 cases, 1230 (60%) were inspected and 823 (40%) had autopsies. Blood samples were collected from 414 autopsy cases. In the remainder, it was not possible to obtain serum.

Our results showed high seroprevalence rates of HIV-1, HBV, and HCV among the forensic autopsy cases in the Office of Chief Medical Examiner, State of Maryland. Nearly one-third of the cases were infected with at least one of these viruses. Although general serologic surveys of HCV have been undertaken and high seroprevalence rates of HCV have been reported among specific risk groups, such as IVDU [*21*], there are few or no data on HCV infection in forensic autopsy populations. The 19% HCV seroprevalence rate found in this study represents one of the highest rates reported in a particular population. We found that HCV was concentrated among cases 30–49 years old, with a slightly higher prevalence among blacks. This compared well with a recent study [*22*]. The seroprevalence of HCV among intravenous drug users (62%) was similar to that found by others in the Baltimore-Washington, DC, area [*23*].

It is very interesting that 50% of anti-HBc positives were anti-HCV positive, while only 10% of anti-HBc negatives were anti-HCV positive. This result indicates that, if one had a HBV infection, the chance of also having or getting an HCV infection is much higher than that of a non-HBV infected person.

The seroprevalence of HBV in our study population was determined by anti-HBc antibodies. The 23% prevalence rate was also very high compared with that reported for a general population [*24*]. Anti-HBc was most commonly found in blacks (28.2%), and men (24.3%). The prevalence of HBV with age showed a steadily increasing trend from 19 to 39. This prevalence remained relatively high after age 39. The distribution of HIV-1 and HCV by age is different from that of HBV. Both HIV-1 and HCV showed a significantly higher rate in the group of 30–39 years old than the remainder of the population. Previous studies also showed a similar trend of HBV, HCV, and HIV-1 infections by age groups [*9,25–27*]. The HBV prevalence in IVDU group was 65.5% in our study which is consistent with other results [*28*].

Data revealing the prevalence of HIV-1 infection in forensic autopsy populations are limited. A study reported previously by our office showed that the prevalence rate of HIV-1 infection in autopsy cases was about 2.5% in 1988 [*29*]. Similar prevalence rates were also reported by two other studies during the same period [*30,31*]. The 5.6%

prevalence rate in the present study is higher than that of previous studies, most likely paralleling the increase in the HIV prevalence in the general population. The HIV-1 seroprevalence rate was much higher in blacks than that of whites ($P < 0.001$), even though the numbers in these two groups in this study were similar. This phenomenon was also found in urban emergency room populations [*26*]. The HIV-1 prevalence rate in the IVDU group was 25.5% in our study, similar to results reported in San Francisco in which the seroprevalence in IVDU was 6–26% [*32*]. The highest prevalence was in age groups between 30–39 years in this study, which was also similar to a previously reported urban emergency room population [*1*].

Homicide victims in our study showed a relatively higher prevalence of HIV-1, HBV, and HCV infections compared with other manners of deaths. Since more than 75% of the 75 homicide cases were male, black, and in the 30–39 years age, and all of these factors were related to high prevalence, this very high prevalence rate is not surprising. There were 78 cases in this study who belong to accidents according to the manner of death. None of them were HIV-1 positive. HBV prevalence in the group of accidents was about 5%, the lowest rate in our study. This group data looks more likely representing the rates among the general population at large except that of the seroprevalence of HCV which showed 16.7% in this group.

The issue of routinely testing patients for HIV-1 as a means of identifying those who may pose risk of infection in an occupational setting has received considerable attention [*33*,*34*]. However, unfortunately no indicator can be used as a universal signal for potential risks for all infectious agents. In our study, we found 86% of HBV or HCV infections occurred without concurrent HIV infection. This means testing for HIV-1 antibody alone would have missed at least 80% of cases positive for HBV or HCV infections. Given the wide distribution of these viruses in this population, routine testing of only HIV-1 would be relatively ineffectual as a means of alerting health care workers to autopsy cases who may pose an occupational risk. Adherence to universal precaution remains the best strategy for this purpose.

The rate of occupational acquisition of HBV among unvaccinated health care providers may be approximately 50 to 100 times higher than the rate for HIV-1, since the risk of transmission after percutaneous exposure to HBsAg-positive blood can be as much as 30% [*17*]. The prevalence of HBV infection among unvaccinated providers who come into frequent contact with blood ranges from 15 to 30%, 3 to 10 times higher than in providers without much contact with blood [*6*].

The risk of occupational acquisition of HCV is only now being assessed. However, there have been several cases of such transmission in an occupational setting [*35–38*]. A recent study reported that acute HCV infection with seroconversion occurred in 3 of 110 providers (2.7%) who had documented needle-stick exposures to the blood of patients with antibodies to HCV [*36*].

Recently, much attention has been devoted to discussions concerning potential risks to health care providers from needle-stick injury. Studies have shown that needlestick injury is fairly common, occurring in at least 5% of operations [*39*]. One report showed that greater than 8.3% of gloves were punctured and 31.8% of these punctures went unnoticed when performing autopsies [*40*]. Therefore, based on the forensic autopsy population seroprevalence and the chance of glove puncture, it is realistic to recognize that there is a great occupational risk posing every forensic pathologist.

In summary, our study provides preliminary evidence of a high prevalence of presumed infectivity of HIV-1, HBV, and HCV in an unselected forensic autopsy population in an inner-city medical examiner's office. Testing for HIV-1 alone will not identify almost 86 percent of HBV or HCV infections in this population. Since vaccines for HIV-1 or HCV are still not available, nor foreseen in the near future, universal precautions should be practiced continually.

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Address requests for reprints or additional information to
Ling Li, M.D.
The Office of the Chief Medical Examiner
State of Maryland
111 Penn St.
Baltimore, MD 21201