SURVEILLANCE OF HEALTH CARE WORKERS EXPOSED TO BLOOD FROM PATIENTS INFECTED WITH THE HUMAN IMMUNODEFICIENCY VIRUS

RUTHANNE MARCUS, M.P.H., AND THE CDC COOPERATIVE NEEDLESTICK SURVEILLANCE GROUP*

Abstract Since 1983, we have conducted national surveillance of health care workers exposed to blood or body fluids from persons infected with the human immunodeficiency virus (HIV), to assess the risk of HIV transmission by such exposures. As of July 31, 1988, 1201 health care workers with blood exposures had been examined, including 751 nurses (63 percent), 164 physicians and medical students (14 percent), 134 laboratory workers (11 percent), and 90 phlebotomists (7 percent).

The exposures resulted from needle-stick injuries (80 percent), cuts with sharp objects (8 percent), open-wound contamination (7 percent), and mucous-membrane exposure (5 percent). We concluded that 37 percent of the exposures might have been prevented.

Of 963 health care workers whose serum has been tested for HIV antibody at least 180 days after exposure, 4 were positive, yielding a seroprevalence rate of 0.42 percent (upper limit of 95 percent confidence interval, 0.95 percent). Three subjects experienced an acute retroviral syndrome associated with documented seroconversion; serum collected within 30 days of exposure was not available from the fourth person. Two exposures that resulted in seroconversion were caused by coworkers during resuscitation procedures.

We conclude that the risk of HIV infection after exposure to the blood of a patient infected with HIV is low, but at least six months of follow-up is recommended. Many exposures can be prevented by careful adherence to existing infection-control precautions, even during emergencies. (N Engl J Med 1988; 319:1118-23.)

IN August 1983, the Centers for Disease Control (CDC), in cooperation with health care institutions throughout the United States, began an ongoing surveillance project to quantitate the risk to health care workers of acquiring infection with the human immunodeficiency virus (HIV) after exposure to the blood or body fluids of patients infected with HIV. An earlier report provided data on the first 451 health care workers enrolled in the project who were tested for HIV antibody.[1] Since that time, an additional 750 health care workers have been evaluated, the surveillance project has evolved to focus on workers exposed to the blood of patients infected with HIV, the length of follow-up for enrolled workers has been shortened to one year, and two new seroconversions have been identified. In this report, we present data collected from the start of the project through July 31, 1988, including details about the health care workers who seroconverted.

METHODS

Eligibility Criteria

When the project was initiated in 1983, health care workers were enrolled if they had had either parenteral or mucous-membrane exposure to the blood or other body fluids of a patient with the acquired immunodeficiency syndrome (AIDS). As of February 1986, no health care worker had seroconverted after a nonparenteral blood exposure, and evolving information strongly pointed to percutaneous exposure to blood as the most likely mechanism of transmission. Therefore, more restrictive criteria for enrollment were instituted: only persons with parenteral exposures to HIV-seropositive blood were accepted (i.e., needle-stick injuries, cuts with sharp objects, and puncture wounds from contaminated instruments).[1] However, concern about the risk of HIV transmission by exposure to blood through means other than needle sticks led to a partial expansion of the enrollment criteria in October 1987 to include mucous-membrane exposure and contamination of nonintact skin by the blood of an HIV-infected patient.[2] Confirmation of HIV infection in the source patient was required on the basis of either clinical condition (a diagnosis of AIDS according to the CDC case definition) or serologic evaluation (positivity for HIV antibody, HIV antigen, or both).

Enrollment

After written informed consent was obtained from the health care worker, epidemiologic data and blood specimens for HIV-antibody testing were collected from each enrollee within 30 days of the exposure. The information collected included demographic data, a medical history, a detailed account of the exposure, and descriptions of infection-control precautions and postexposure treatment (e.g., immune serum globulin, hepatitis B immune globulin, or hepatitis B vaccine). A physical examination and total and differential white-cell counts were performed at the institution where the exposure occurred. The health-care workers each completed a separate, confidential questionnaire about any nonoccupational behavior that might have put them at risk for HIV infection at the time of the exposure; the questionnaire was mailed directly to the CDC without being reviewed by personnel at the institution.

Prospective Surveillance

Initially, the health care workers were monitored at six-month intervals for a three-year observation period to detect signs of clinical AIDS. HIV antibody testing became available in 1985, and in 1986 the follow-up period was shortened to one year to detect seroconversion. Health care workers were monitored prospectively with follow-up physical examinations and blood specimens collected at intervals of 6 weeks and 3, 6, and 12 months after the date of the exposure. Seroconversion was defined as occurring when a health care worker who had been found seronegative for HIV antibody on the basis of a serum sample collected no more than 30 days after the exposure was found seropositive on a specimen collected 90 days or more after the exposure. All health care workers who seroconverted to HIV were interviewed by a CDC epidemiologist to

From the Hospital Infections Program, Center for Infectious Diseases, Centers for Disease Control, Atlanta. Address reprint requests to Ms. Marcus at the Epidemiology Branch, Hospital Infections Program, Bldg. 1–Rm. 5064, Mailstop C10, Center for Infectious Diseases, Centers for Disease Control, Atlanta, GA 30333.

*The Cooperative Needlestick Surveillance Group consists of 10 investigators from the Centers for Disease Control and cooperating investigators from 335 institutions nationwide. The following investigators each enrolled more than 15 health care workers who participated in this study: Kathleen S. Bean, R.N., B.S.N., Fairfax Hospital, Falls Church, Va.; Michela T. Catalano, M.D., Montefiore Medical Center, Bronx, N.Y.; Sally Bunce Turner, R.N., M.S., Boston City Hospital, Boston; Evelyn J. Fisher, M.D., Henry Ford Hospital, Detroit; John V. Gaeuman, M.D., Ohio State University Hospitals, Columbus; Robert Harrison, M.D., University of California–San Francisco, San Francisco; Victoria Heitzer, R.N., South Miami Hospital, Miami, Fla.; William L. Hoppes, M.D., Timken Mercy Medical Center, Canton, Ohio; Marguerite Jackson, M.S., University of California San Diego Medical Center, San Diego; John R. Middleton, M.D., Raritan Bay Medical Center, Perth Amboy, N.J.; Dee Sluder, Memorial Mission Hospital, Asheville, N.C.; Rachel L. Stricof, M.P.H., New York State Department of Health, Albany; Georgia Thomas, M.D., University of Texas–M.D. Anderson Cancer Center, Houston; William Valenti, M.D., Strong Memorial Hospital–University of Rochester, Rochester, N.Y.

The New England Journal of Medicine
Downloaded from nejm.org at The University Of Illinois at Chicago on March 25, 2020. For personal use only. No other uses without permission.
From the NEJM Archive. Copyright © 2010 Massachusetts Medical Society. All rights reserved.

review the details of the exposure and to identify other possible risk factors for HIV infection.

Laboratory Methods

HIV-antibody testing was performed at the CDC with either the Abbott Laboratories (Abbott Park, Ill.) or the GeneticSystems (Seattle) commercial kits for enzyme immunoassay. All specimens reactive by this method were retested and, if again found positive, were assessed by a CDC-prepared Western blot assay as described by Tsang et al.[3] Specimens were defined as positive by Western blot assay if both p24 and gp41 bands were visible. All indeterminate results by Western blot assay (e.g., positive for the p24 band only) were repeated on subsequent samples. In all cases, HIV seropositivity was confirmed by the examination of additional specimens from the health care worker.

An experimental antigen-capture assay (Abbott Laboratories) was used to perform HIV antigen testing on serum samples from health care workers who seroconverted. Whole-blood specimens were requested from workers who seroconverted to determine lymphocyte subsets with use of standard methods and commercially available direct immunofluorescence reagents (monoclonal antibodies conjugated with a phycoerythrin derivative; Coulter Immunology, Hialeah, Fla.).[4] HIV isolation was attempted by the cocultivation of lymphocytes with use of the methods previously described.[5]

Blood specimens were requested from the source patients, particularly the asymptomatic patients, to verify HIV seropositivity.

Statistical Analysis

Data were analyzed with the Statistical Analysis System. The upper bound of the 95 percent confidence interval was calculated with use of the binomial distribution to determine the risk of seroconversion for the tested health care workers.

Results

Health Care Workers

As of July 31, 1988, a total of 1613 health care workers met the eligibility criteria and were enrolled in the surveillance project. Of these, 21 did not submit blood samples for HIV-antibody testing, 285 did not provide consent for such testing, and 106 were exposed to body fluids other than blood (56 to saliva, 16 to urine, and 34 to other or unknown fluids); all were excluded from analysis. None of the workers exposed to fluids other than blood seroconverted. Thus, 1201 health care workers who were exposed to blood from a patient infected with HIV or a patient meeting the CDC case definition for AIDS form the basis of this report. Of these, 962 (80 percent) received needlestick injuries, 103 (8 percent) were cut with sharp objects, 79 (7 percent) had contaminated open wounds, and 57 (5 percent) had contaminated mucous membranes.

The exposures occurred in various hospital settings: 779 health care workers (65 percent) were exposed in a patient's room, on a ward, or in an outpatient clinic; 161 (14 percent) in an intensive care unit; 87 (7 percent) in an operating room; 84 (7 percent) in a laboratory; 62 (5 percent) in an emergency room; and 28 (2 percent) in a morgue. The enrolled workers included 751 nurses (63 percent), 164 physicians or medical students (14 percent), 134 technicians or laboratory workers (11 percent), 90 phlebotomists (7 percent), 36 respiratory therapists (3 percent), and 26 housekeeping or maintenance workers (2 percent).

Of the 1201 health care workers tested, 1087 (91 percent) completed the confidential questionnaire eliciting information about behavior involving possible risk for HIV infection at the time of the exposure. Of these 1087 workers, 6 (who were men) reported themselves to be homosexual or bisexual, 4 reported having used intravenous drugs after 1978, and 6 reported sexual contact with a person known to be at risk for HIV infection. These workers reporting behavioral risk factors for HIV infection were retained in the analysis.

Source Patients

Of the source patients infected with HIV for whom epidemiologic data were complete, 85 percent met the CDC case definition for AIDS. An additional 9 percent had symptoms of HIV infection but did not fulfill the CDC case definition for AIDS, and 6 percent were HIV-antibody positive but asymptomatic. Serum samples from 25 (40 percent) of the 62 asymptomatic source patients were sent to the CDC for verification of HIV seropositivity.

Circumstances of Exposures

Of the 1201 exposures, 37 percent might have been prevented if the health care worker had been using recommended infection-control precautions. These potentially preventable exposures involved recapping used needles by hand (17 percent), the improper disposal of used needles or sharp objects (14 percent), and the contamination of an open wound (6 percent). The remaining 63 percent of the exposures occurred during the manipulation of an intravenous, phlebotomy, or arterial needle (36 percent), during the performance of an invasive procedure (8 percent), during autopsy (2 percent), or during various other procedures (17 percent).

Length of Follow-up

In 963 of the 1201 health care workers, a serum sample was tested for HIV antibody at least 180 days after the exposure; the remaining 238 workers have not yet completed 180 days of follow-up. Specimens have been tested at least 12 months after the exposure for 752 and 24 months after the exposure for 248 (Fig. 1). Specimens collected within 30 days of the exposure were also available from 622 of the 1201 health care workers.

Risk to Health Care Workers

Since health care workers who tested negative for HIV antibody after 180 days can be assumed to have been negative at base line, all 963 workers tested after 180 days were included in the denominator used to calculate the seroprevalence and seroconversion rates. The 963 workers included 860 (89 percent) who had received either a needle stick or a cut with a sharp instrument; 4 of these workers were seropositive (seroprevalence rate, 4 of 860 or 0.47 percent; upper limit of 95 percent confidence interval, 1.06 percent) (Table 1). One of these four seropositive workers was first tested 10 months after a needle-stick

The New England Journal of Medicine
Downloaded from nejm.org at The University Of Illinois at Chicago on March 25, 2020. For personal use only. No other uses without permission.
From the NEJM Archive. Copyright © 2010 Massachusetts Medical Society. All rights reserved.

exposure to the blood of a patient infected with HIV, and no specimen obtained within 30 days of exposure was available for testing. This case of a seropositive health care worker has been reported previously.[1,6] The remaining three workers represent seroconversions (seroconversion rate, 3 of 860 or 0.35 percent; upper limit of the 95 percent confidence interval, 0.90 percent) and are further described below. No health care worker who was negative at six months seroconverted during the remainder of his or her follow-up period.

Table 1. Seroprevalence of HIV Antibody in Health Care Workers Exposed to Blood from Patients Infected with HIV, August 15, 1983, to July 31, 1988.

Type of Exposure	No. Tested	No. Positive	Infections per 100 Workers*
Needle stick or cut with sharp object	860	4	0.47 (1.06)
Contamination of mucous membrane or nonintact skin	103	0	0.00 (2.84)
Total	*963*	*4*	*0.42 (0.95)*

*Values in parentheses are upper limits of 95 percent confidence intervals.

Details of Seroconversions

Three workers, all with needle-stick exposures to the blood of a person infected with HIV, tested negative for HIV antibody, had an acute retroviral illness, and subsequently tested positive for HIV antibody. None had other risk factors for HIV infection. The first worker, previously described, received a deep intramuscular needle stick from a large-bore needle, inflicted by a coworker during a resuscitation procedure in a patient with AIDS[7] (Stricof R: personal communication) (Table 2). This worker first tested negative for HIV antibody nine days after the injury. Fourteen days after the exposure, fever, chills, myalgia, and arthralgia developed. Subsequent serologic tests on days 184, 239, 338, 464, and 590 were positive for HIV antibody by enzyme immunoassay and Western blot assay. No opportunistic infections indicative of AIDS have developed in this health care worker, and the worker's spouse has remained seronegative for HIV as of day 590.

The second worker, like the first, received a deep needle-stick injury from a 21-gauge needle held by a coworker during a resuscitation attempt in a patient with AIDS. Serum collected from the worker the next day was negative for HIV antibody and antigen. Four weeks later, the worker became ill with fever, shaking chills, night sweats, lymphadenopathy, and malaise. The symptoms resolved in approximately four days. Eighty-eight days after the exposure, HIV-antibody testing showed positive enzyme immunoassay and a p24 band on the Western blot; at 121 days, both p24 and gp41 bands were visible on the Western blot. No attempts at viral isolation have been made by the CDC; serum antigen tests were negative on days 88 and 121. A recent sex partner tested negative for HIV antibody.

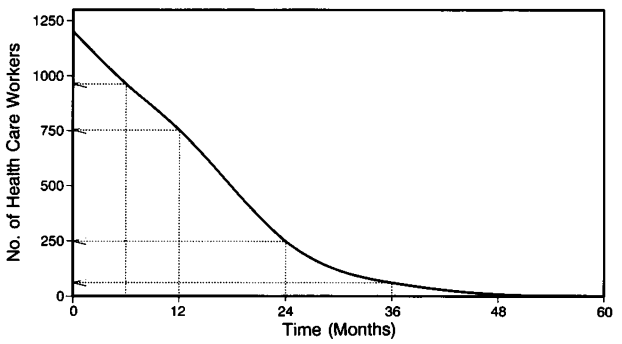

Figure 1. Length of Follow-up of Health Care Workers after Exposure to HIV-Infected Blood, August 15, 1983, to July 31, 1988.

The third seroconversion occurred in a health care worker who received two needle-stick injuries 10 days apart. The first exposure occurred while the worker was recapping a needle that had been used in a patient with AIDS. The second needle stick occurred when the worker accidentally stuck herself with a needle after drawing blood from a patient with symptomatic HIV infection. After removing the tube of blood from the plastic needle holder, the worker placed the needle holder upright on its base, so that the needle was pointed vertically into the air. She then turned away and subsequently injured herself on the exposed needle. The base-line serum sample drawn for HIV testing 21 days after the first exposure (and 11 days after the second exposure) was negative for HIV antibody and antigen. Four weeks after the first exposure, the worker was hospitalized for approximately three weeks with an acute febrile illness characterized by shaking chills, dehydration, nausea, malaise, bilateral lymphadenopathy, and weight loss of more than 4.5 kg. Serum tested during this illness, on the 42nd day after the first exposure was negative for HIV antibody and antigen. However, viremia was demonstrated; cultures of lymphocytes collected at this time were positive for reverse transcriptase activity and HIV-antigen production. Repeated enzyme immunoassay tests for HIV antibody were positive, but the Western blot assay was indeterminate, demonstrating only a p24 band. The results of tests performed 121, 156, and 275 days after the first exposure were positive for HIV antibody by both enzyme immunoassay and Western blot assay, with both p24 and gp41 proteins visible on the Western blot test. Virus was isolated from the health care worker's lymphocytes 156 days after the first exposure. An enzyme immunoassay for HIV antibody in the worker's spouse four months after the worker's exposure was negative.

Discussion

This continuing surveillance project was designed to estimate the risk to health care workers of HIV infection from a documented parenteral or mucous-membrane exposure to the blood of a patient infected with HIV. Henderson et al. have reported no seroconversion among 332 health care workers with 453 exposures to the blood and body fluids of patients infected with HIV at the National Institutes of Health's Clini-

The New England Journal of Medicine
Downloaded from nejm.org at The University Of Illinois at Chicago on March 25, 2020. For personal use only. No other uses without permission.
From the NEJM Archive. Copyright © 2010 Massachusetts Medical Society. All rights reserved.

Table 2. Characteristics and Laboratory Profile of Three Health Care Workers Who Seroconverted to HIV after a Needle-Stick Injury.*

Worker No.	Characteristics of Injury			Days after Exposure	Antibody Test			Serum Antigen	Cell Culture	Retroviral Syndrome?
	Occasion	Needle Size	Self-Inflicted?		EIA	WB				
						p24	*gp41*			
1	Resuscitation	Large bore	No	9	−	NT		−	−	Yes
				184	+	+	+	NT	NT	
				239	+	+	+	−	−	
				338	+	+	+	NT	−	
				464	+	+	+	NT	NT	
				590	+	+	+	NT	−	
2	Resuscitation	21 Gauge	No	1	−	NT		−	NT	Yes
				88	+	+	−	−	NT	
				121	+	+	+	−	NT	
3	Recapping, improper disposal of needle	21 to 25 Gauge†	Yes	21‡	−	NT		−	NT	Yes
				42	−	NT		−	+	
				78	+	+	−	NT	NT	
				121	+	+	+	NT	−	
				156	+	+	+	NT	+	
				275	+	+	+	NT	NT	

*EIA denotes enzyme immunoassay, WB Western blotting, and NT not tested. Minus signs denote negative test results and plus signs positive results.

†For both exposures.

‡Values are the numbers of days after Worker 3's first exposure.

cal Center.[8,9] At San Francisco General Hospital, Gerberding et al. have followed 129 employees with documented exposures to the blood or body fluids of patients infected with HIV; one employee has seroconverted.[9-11] At the University of California–Los Angeles Medical Center, Kuhls et al. found no HIV transmission in 102 female health care workers with "high exposure" to patients infected with HIV or in 43 with "low exposure."[12] Of the 102 in the high-exposure group, 25 had either a needle-stick or a mucous-membrane exposure. In the United Kingdom, McEvoy et al. tested 150 health care workers with percutaneous and mucous-membrane exposures to the blood and body fluids of HIV-infected patients; none seroconverted.[13]

Fourteen reports of seroconversion in health care workers have been published in addition to the three presented here.[14-17] Nine cases of seroconversion occurred after injuries with needles or sharp instruments,[14-24] and four after other forms of exposure to the blood of patients infected with HIV.[2,21] One additional case of seroconversion has been documented, outside a health care setting; the person involved provided nursing care to a person infected with HIV and was not using recommended infection-control precautions.[25]

The certainty with which possible high-risk behavior can be excluded in these episodes varies, since many health care workers were questioned after the exposure and seroconversion. Although the workers might have denied other kinds of high-risk behavior after an injury and seroconversion, one strength of our study was that each worker was interviewed by hospital personnel and completed a confidential risk-factor questionnaire at the time of the injury, before seroconversion occurred.

The effect of the patient's clinical status on the risk of transmission of HIV to health care workers remains uncertain. In this surveillance project, 94 percent of the patients were symptomatic, and the three health care workers who seroconverted had been exposed to symptomatic patients. In addition, two of the three workers who seroconverted to HIV were exposed to patients' blood during resuscitation procedures when the patient was terminally ill with AIDS. Some data suggest that symptoms alone may be less predictive of infectivity than immune status, as measured by the number of T4 cells. In a study of the sex partners of a small number of persons with hemophilia, Goedert et al. concluded that transmission of HIV was more likely to occur as the index patients' numbers of T4 cells decreased.[26] Other authors have reported a reappearance of HIV antigen after clinical symptoms develop.[27]

Careful and consistent use of infection-control precautions with all patients is the primary means of protection against the nosocomial acquisition of blood-borne diseases. Extensive guidelines have been published for preventing the transmission of blood-borne pathogens in health care settings.[9,28,29] These guidelines emphasize the importance of training and education, engineering controls, work practices, and personal protective equipment. Jagger et al. have also stressed the need for improved equipment design to prevent needle-stick injury.[30]

Because it is often impossible to know a patient's infection status, these recommendations focus on the use of universal precautions in handling blood and other body fluids containing the visible blood of any patient. To date, blood is the only body fluid that has been implicated in the transmission of HIV in the health care setting. Workers who anticipate touching blood or body fluids contaminated with blood should wear gloves. Other barrier precautions such as gowns, masks, and eye coverings should be worn if the worker is performing a procedure that may cause splattering of blood or blood-tainted material onto the skin or mucous membranes.

In addition, these recommendations stress the importance of care in handling all needles and sharp

The New England Journal of Medicine
Downloaded from nejm.org at The University Of Illinois at Chicago on March 25, 2020. For personal use only. No other uses without permission.
From the NEJM Archive. Copyright © 2010 Massachusetts Medical Society. All rights reserved.

objects used with patients. Such instruments should not be recapped, bent, broken, or manipulated by hand. All sharp instruments should be disposed of in puncture-resistant containers located as close as possible to the area of use. In more than 200 injuries associated with the recapping of needles in our study, one seroconversion resulted.

If a health care worker has a parenteral or mucous-membrane exposure to the blood of a patient, that patient should be tested for HIV antibody with his or her consent.[9] If the test is negative, no further follow-up for HIV is necessary. The rare exception may be the patient at high risk for HIV infection who has recently been exposed to the virus and may not yet have produced antibody. If the patient has AIDS, is HIV positive, or does not consent to testing, the health care worker should be evaluated serologically as soon as possible after the exposure. If the worker is seronegative, he or she should be retested at 6 weeks, 12 weeks, and 6 months after the exposure. In our project, health care workers are followed for at least 12 months. In all cases, a base-line serologic test is important to evaluate the worker's current infection status. Policies for examining health care workers exposed to hepatitis B virus[31] should be adhered to independently of HIV status.

In two of the three cases we describe, seroconversion evolved over a period of 4 to 12 weeks, emphasizing the need to evaluate serial specimens from health care workers exposed to the blood of HIV-infected patients. In both workers, the first positive enzyme immunoassay was followed by a Western blot assay that was positive for p24 only. Western blotting approximately one month later identified both the p24 and gp41 bands. This sequence of antibody response has been demonstrated in studies comparing various methods of HIV-antibody testing.[32] The authors of these studies have also reported on the detection of viral antigen during the acute retroviral illness. In our second case, HIV was cocultivated from lymphocytes during the acute illness, but the serum antigen test was negative.

Seroconversion is most likely to occur within the first 6 to 12 weeks after an exposure.[7,14,15,18,19,21,33-35] In 12 of the 17 published reports of seroconversion in health care workers, an acute febrile illness has been noted within 12 weeks of the exposure. This acute retroviral syndrome has been reported in others exposed to HIV,[32-39] but health care workers provide an opportunity to monitor the natural history of infection in an otherwise healthy population. Symptoms such as fever, rash, malaise, unexplained weight loss, and lymphadenopathy are most commonly present. Health care workers who experience similar symptoms after parenteral or mucous-membrane exposure to the blood or blood-containing body fluids of a person infected with HIV should seek immediate medical attention. Although it has been proposed that only workers who have such an acute illness require continued follow-up, we believe that the natural history of nosocomial HIV infection needs further study before such limited evaluation can be recommended.[40] In the second case presented here, the worker had relatively mild symptoms that might have gone unreported in the absence of a known parenteral exposure to the blood of an HIV-infected patient.

In this surveillance project, we have found that the risk of seroconversion after documented exposure to the blood of a patient infected with HIV is low. However, the need for compliance with recommended infection-control precautions to prevent exposures cannot be overemphasized. The fact that two of the three health care workers who seroconverted to HIV were injured by coworkers during resuscitation procedures underscores the need to handle sharp instruments carefully in all circumstances, even during emergencies.

References

1. McCray E, Cooperative Needlestick Surveillance Group. Occupational risk of the acquired immunodeficiency syndrome among health care workers. N Engl J Med 1986; 314:1127-32.
2. Update: human immunodeficiency virus infections in health-care workers exposed to blood of infected patients. MMWR 1987; 36:285-9.
3. Tsang VC, Peralta JM, Simons AR. Enzyme-linked immunoelectrotransfer blot technique (EITB) for studying the specificities of antigens and antibodies separated by gel electrophoresis. Methods Enzymol 1983; 92:377-91.
4. Nicholson JKA, Jones BM, Cross GD, McDougal JS. Comparison of T and B cell analyses on fresh and aged blood. J Immunol Methods 1984; 73:29-40.
5. Feorino PM, Kalyanaraman VS, Haverkos HW, et al. Lymphadenopathy associated virus infection of a blood donor–recipient pair with acquired immunodeficiency syndrome. Science 1984; 225:69-72.
6. Weiss SH, Saxinger WC, Rechtman D, et al. HTLV-III infection among health care workers: association with needle-stick injuries. JAMA 1985; 254:2089-93.
7. Stricof RL, Morse DL. HTLV-III/LAV seroconversion following a deep intramuscular needlestick injury. N Engl J Med 1986; 314:1115.
8. Henderson DK, Saah AJ, Zak BJ, et al. Risk of nosocomial infection with human T-cell lymphotropic virus type III/lymphadenopathy-associated virus in a large cohort of intensively exposed health care workers. Ann Intern Med 1986; 104:644-7.
9. Recommendations for prevention of HIV transmission in health-care settings. MMWR 1987; 36:Suppl 2S:1S-18S.
10. Gerberding JL, Bryant-LeBlanc CE, Nelson K, et al. Risk of transmitting the human immunodeficiency virus, cytomegalovirus, and hepatitis B virus to health care workers exposed to patients with AIDS and AIDS-related conditions. J Infect Dis 1987; 156:1-8.
11. Gerberding JL, Henderson DK. Design of rational infection control policies for human immunodeficiency virus infection. J Infect Dis 1987; 156:861-4.
12. Kuhls TL, Viker S, Parris NB, Garakian A, Sullivan-Bolyai J, Cherry JD. Occupational risk of HIV, HBV and HSV-2 infections in health care personnel caring for AIDS patients. Am J Public Health 1987; 77:1306-9.
13. McEvoy M, Porter K, Mortimer P, Simmons N, Shanson D. Prospective study of clinical, laboratory, and ancillary staff with accidental exposures to blood or body fluids from patients infected with HIV. Br Med J 1987; 294:1595-7.
14. Update: acquired immunodeficiency syndrome and human immunodeficiency virus infection among health-care workers. MMWR 1988; 37:229-39.
15. Michelet C, Cartier F, Ruffault A, Camus C, Genetet N, Thomas R. Needlestick HIV infection in a nurse. Presented at the Fourth International Conference on AIDS, Stockholm, June 12–16, 1988. abstract.
16. Barnes DM. Health workers and AIDS: questions persist. Science 1988; 241:161-2.
17. Wallace MR, Harrison WO. HIV seroconversion with progressive disease in a health care worker after needlestick injury. Lancet 1988; 1:1454.
18. Needlestick transmission of HTLV-III from a patient infected in Africa. Lancet 1984; 2:1376-7.
19. Oksenhendler E, Harzic M, Le Roux J-M, Rabian C, Clauvel JP. HIV infection with seroconversion after a superficial needlestick injury to the finger. N Engl J Med 1986; 315:582.
20. Neisson-Vernant C, Arfi S, Mathez D, Leibowitch J, Monplaisir N. Needlestick HIV seroconversion in a nurse. Lancet 1986; 2:814.
21. Gioannini P, Sinicco A, Cariti G, Lucchini A, Paggi G, Giachino O. HIV infection acquired by a nurse. Eur J Epidemiol 1988; 4:119-20.

The New England Journal of Medicine
Downloaded from nejm.org at The University Of Illinois at Chicago on March 25, 2020. For personal use only. No other uses without permission.
From the NEJM Archive. Copyright © 2010 Massachusetts Medical Society. All rights reserved.

22. Ramsey KM, Smith EN, Reinarz JA. Prospective evaluation of 44 health care workers exposed to human immunodeficiency virus-1, with one seroconversion. Clin Res 1988; 36:22A. abstract.
23. Weiss SH, Goedert JJ, Gartner S, et al. Risk of human immunodeficiency virus (HIV-1) infection among laboratory workers. Science 1988; 239:68-71.
24. 1988 Agent summary statement for human immunodeficiency virus and report on laboratory-acquired infection with human immunodeficiency virus. MMWR 1988; 37:Suppl S-4:1-22.
25. Apparent transmission of HTLV-III/LAV from a child to a mother providing health care. MMWR 1986; 35:76-9.
26. Goedert JJ, Eyster ME, Biggar RJ, Blattner WA. Heterosexual transmission of human immunodeficiency virus: association with severe depletion of T-helper lymphocytes in men with hemophilia. AIDS Res Hum Retroviruses 1987; 3:355-61.
27. Goudsmit J, de Wolf F, Paul DA, et al. Expression of human immunodeficiency virus antigen (HIV-Ag) in serum and cerebrospinal fluid during acute and chronic infection. Lancet 1986; 2:177-80.
28. Update: universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus, and other bloodborne pathogens in health-care settings. MMWR 1988; 37:377-88.
29. Department of Labor. Joint advisory notice: protection against occupational exposure to hepatitis B virus (HBV) and human immunodeficiency virus (HIV). Washington, D.C.: Department of Health and Human Services, 1987.
30. Jagger J, Hunt EH, Brand-Elnaggar J, Pearson RD. Rates of needle-stick injury caused by various devices in a university hospital. N Engl J Med 1988; 319:284-8.
31. Recommendations for protection against viral hepatitis. MMWR 1985; 34:313-35.
32. Gaines H, von Sydow M, Sönnerborg A, et al. Antibody response in primary human immunodeficiency virus infection. Lancet 1987; 1: 1249-53.
33. Cooper DA, Gold J, Maclean P, et al. Acute AIDS retrovirus infection: definition of a clinical illness associated with seroconversion. Lancet 1985; 1:537-40.
34. Ho DD, Sarngadharan MG, Resnick L, Dimarzo-Veronese F, Rota TR, Hirsch MS. Primary human T-lymphotropic virus type III infection. Ann Intern Med 1985; 103:880-3.
35. Fincher R-ME, de Silva M, Lobel S, Spencer M. AIDS-related complex in a heterosexual man seven weeks after a transfusion. N Engl J Med 1985; 313:1226-7.
36. Kaplan JE, Spira TJ, Feorino PM, Warfield DT, Fishbein DB. HTLV-III viremia in homosexual men with generalized lymphadenopathy. N Engl J Med 1985; 312:1572-3.
37. Kessler HA, Blaauw B, Spear J, Paul DA, Falk LA, Landay A. Diagnosis of human immunodeficiency virus infection in seronegative homosexuals presenting with an acute viral syndrome. JAMA 1987; 258:1196-9.
38. Wall RA, Denning DW, Amos A. HIV antigenaemia in acute HIV infection. Lancet 1987; 1:566.
39. Biggar RJ, Johnson BK, Musoke SS, et al. Severe illness associated with appearance of antibody to human immunodeficiency virus in an African. Br Med J 1986; 293:1210-1.
40. Kuhls TL, Cherry JD. The management of health care workers' accidental parenteral exposures to biological specimens of HIV seropositive individuals. Infect Control 1987; 8:211-3.

HUMAN IMMUNODEFICIENCY VIRUS INFECTION AMONG EMPLOYEES IN AN AFRICAN HOSPITAL

Bosenge N'Galy, M.D., Robert W. Ryder, M.D., M.Sc., Kapita Bila, M.D., Kashamuka Mwandagalirwa, Robert L. Colebunders, M.D., Henry Francis, M.D., Jonathan M. Mann, M.D., M.P.H., and Thomas C. Quinn, M.D.

Abstract To define the prevalence and course of human immunodeficiency virus (HIV) infection, we examined prospectively a cohort of 2002 adult hospital workers in Kinshasa, Zaire.

From 1984 to 1986 the prevalence of HIV infection increased from 6.4 percent to 8.7 percent. Over the two years there was a cumulative incidence of new HIV infection of 3.2 percent. The prevalence was higher among women (16.9 percent) and men (9.3 percent) under the age of 30 than among women (9.0 percent) and men (6.2 percent) over 30. Prevalence rates were similar among physicians (5.6 percent), laboratory workers (2.9 percent), and clerical workers (7.9 percent), but they were higher among female nurses (11.4 percent) and manual workers (11.8 percent). Despite marked differences in the intensity of nosocomial exposure, female nurses had similar infection rates on the female internal medicine ward (9.9 percent), in pediatrics (10.8 percent), and in the delivery room (10.7 percent). The attributable risk of HIV infection from a transfusion was 5.9 percent. Neither medical injections nor scarification was a risk factor for HIV infection. Of the 101 seropositive asymptomatic employees in the 1984 survey, 16 percent had AIDS-related complex, 3 percent had AIDS, and 12 percent had died of AIDS by 1986.

Previous studies have revealed a seroprevalence of 8.4 percent among women attending an antenatal clinic near the hospital in 1984 and 1986, and of 5.8 percent (in 1984) and 6.5 percent (in 1986) among men donating blood at the hospital's blood bank.

We conclude that there is a continuing high prevalence of HIV infection among hospital workers in Kinshasa, Zaire, which appears to be representative of that in the community and not nosocomial. (N Engl J Med 1988; 319:1123-7.)

SEVERAL studies in Africa have demonstrated the importance of human immunodeficiency virus (HIV) infection in selected African populations.[1-5] A 1984 prevalence study in Kinshasa, Zaire, among employees at Mama Yemo Hospital, indicated that being young and unmarried and having received a blood transfusion were risk factors for seropositivity.[6] Despite these studies, little information exists on the incidence of HIV infection in Africa, the evolution of the disease, or the prognosis. In addition, knowledge of the natural history of this infection is based almost exclusively on studies in homosexual or bisexual men and intravenous drug abusers and may not accurately predict the natural history in heterosexual persons who do not abuse drugs. To define better the risk factors associated with HIV infection and disease progression and to assess the risk of infection among em-

From the Projet SIDA (B.N., R.W.R., K.M., R.L.C., H.F., J.M.M.) and the National AIDS Control Program (B.N.), Department of Public Health, Kinshasa, Zaire; the Centers for Disease Control, Atlanta (R.W.R.); Boston University School of Public Health, Boston (R.W.R.); Mama Yemo Hospital, Kinshasa (K.B.); Institute of Tropical Medicine, Antwerp, Belgium (R.L.C.); Laboratory of Immunoregulation, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Md. (H.F., T.C.Q.); and the Global Programme on AIDS, World Health Organization, Geneva, Switzerland (J.M.M.). Address reprint requests to Dr. Ryder, c/o Mr. Dennis Olsen, AIDS Program, Centers for Disease Control, Atlanta, GA 30333.

The New England Journal of Medicine
Downloaded from nejm.org at The University Of Illinois at Chicago on March 25, 2020. For personal use only. No other uses without permission.
From the NEJM Archive. Copyright © 2010 Massachusetts Medical Society. All rights reserved.