CENTERS FOR DISEASE CONTROL

January 1, 1988/Vol. 36/Nos. 50 & 51

MMWR

MORBIDITY AND MORTALITY WEEKLY REPORT

Epidemiologic Notes and Reports

Tuberculosis, Final Data — United States, 1986

In 1986, 22,768 cases of tuberculosis (9.4/100,000 U.S. population) were reported to CDC. These data represent an increase of 2.6% in the number of reported cases, or 567 more than the 22,201 cases reported in 1985 (9.3/100,000 population). If the trend of decline observed between 1981 and 1984 had continued through 1986, 4,832 fewer cases would have been expected during the period 1985-1986 than were actually reported.

The number of reported cases of tuberculosis increased in 25 states and the District of Columbia. The largest increases occurred in New York (+357), New Jersey (+179), Michigan (+75), Arkansas (+63), Florida (+53), and North Carolina (+53). The largest increases in cities with a population of 250,000 or more were reported from New York City (+380), Detroit (+74), New Orleans (+29), Memphis (+27), and Jacksonville (+23).

From 1985 to 1986, the number of tuberculosis cases increased for all racial/ethnic groups except American Indians/Alaskan Natives (Table 1). The largest increases occurred among blacks (+367) and white Hispanics (+123). The 25- to 44-year age group had the most substantial increase in cases (+558). In this group, cases among blacks increased by 250 (from 2,943 to 3,193), or 8.5%; cases among non-Hispanic whites increased by 164 (from 1,520 to 1,684), or 10.8%; and cases among white Hispanics, by 151 (from 1,123 to 1,274), or 13.4%. Increases occurred among both males and females and among persons born in the United States and in foreign countries.

Reported by: Div of Tuberculosis Control, Center for Prevention Svcs, CDC.

Editorial Note: From 1963 to 1985, the incidence rate of tuberculosis in the United States declined an average of 5.9% annually. The average annual decline from 1981 to 1984 was 1,706 cases (6.7%). In contrast, the decrease from 1984 to 1985 was 54 cases (0.2%) (*1*). 1986 marks the first occurrence of a substantial increase in indigenous tuberculosis morbidity since 1953, the year when uniform national reporting was fully implemented. Previously, increases in the number of cases reported had been due either to changes in reporting criteria (1963 and 1975) or to a sudden influx of refugees from Kampuchea, Laos, and Vietnam (1980).

The most substantial increases in number of cases from 1985 to 1986 occurred among blacks, non-Hispanic whites, and white Hispanics in the 25- to 44-year age

Tuberculosis — Continued

group. In contrast, the number of reported tuberculosis cases among children under 5 years of age decreased substantially. This age-specific variation in tuberculosis morbidity indirectly suggests that the recent increase in tuberculosis may be the result of endogenous reactivation of latent, subclinical tuberculous infection rather than of increased transmission.

The increase was greater in New York City than in any other locality. For the past several years, New York City has reported a large increase in tuberculosis among 25- to 44-year-old males that has coincided with the epidemic of acquired immunodeficiency syndrome (AIDS) (*2*). Matching of AIDS and tuberculosis cases on citywide registries revealed that 5% (261) of the first 4,892 adult and adolescent patients reported as having AIDS also had tuberculosis. For the majority of New York City patients, diagnosis of tuberculosis preceded the diagnosis of AIDS. Furthermore, when 58 male patients with tuberculosis in the 25- to 44-year age group were tested,

TABLE 1. Changes in the number of reported tuberculosis cases and the incidence rates (per 100,000 population), by patients' age, race/ethnicity, sex, and country of origin — United States, 1985 and 1986

	Tuberculosis Cases					
	1985		1986		Change	
Patient Characteristics	No.	Rate	No.	Rate	No.	(%)
Age (years)						
0-4	789	4.4	724	4.0	−65	(−8.2)
5-14	472	1.4	490	1.4	+18	(+3.8)
15-24	1,672	4.2	1,719	4.4	+47	(+2.8)
25-44	6,758	9.2	7,316	9.6	+558	(+8.3)
45-64	6,138	13.7	6,119	13.6	−19	(−0.3)
≥65	6,356	22.3	6,393	21.9	+37	(+0.6)
Unknown	16	—	7	—	—	—
Race/Ethnicity						
White, Non-Hispanic	8,453	4.5	8,539	4.6 *	+86	(+1.0)
White, Hispanic	3,032	17.5 †	3,155	17.7 †	+123	(+4.1)
Black§	7,719	26.7	8,086	27.6	+367	(+4.8)
Asian/Pacific Islander§	2,530	49.6	2,572	50.4 *	+42	(+1.7)
American Indian/ Alaskan Native	397	25.0	335	21.1 *	−62	(−15.6)
Unknown	70	—	81	—	—	—
Sex						
Male	14,496	12.5	14,835	12.6	+339	(+2.3)
Female	7,704	6.3	7,933	6.4	+229	(+3.0)
Unknown	1	—	0	—	—	—
Country of Origin¶						
United States	15,641	NA **	16,039	NA **	+398	(+2.5)
Puerto Rico	172	NA **	210	NA **	+38	(+22.1)
Foreign Countries	4,390	NA **	4,513	NA **	+123	(+2.8)
Total	**22,201**	**9.3**	**22,768**	**9.4**	**+567**	**(+2.6)**

*Based on 1985 population estimates.
†Based on total Hispanic population.
§Includes Hispanics.
¶Excludes cases among patients from Texas because that state did not report country of origin in 1985.
**NA = Not available.

Tuberculosis – Continued

53% (31) were positive for human immunodeficiency virus (HIV) antibody (New York City Department of Health, unpublished data).

In Florida, 10% (109) of the first 1,094 patients reported as having AIDS also had tuberculosis (*3*). The proportion of known AIDS patients with tuberculosis was 2% among non-Hispanic whites, 7% among Hispanics, 15% among blacks (excluding Haitians), and 29% among Haitians (*4*). In Dade County, Florida, 31% of the consecutively tested patients with tuberculosis were HIV positive (*5*).

Available data reinforce previous *MMWR* reports (*2,3*) and suggest that the number of patients known to have both tuberculosis and AIDS may represent only a small proportion of the patients with tuberculosis who are infected with HIV. HIV infection, when acquired by a patient with latent tuberculous infection, seems to allow the progression to overt clinical tuberculosis. Thus, HIV infection may be largely responsible for the increase in tuberculosis in New York City and Florida. Epidemiologic investigations and HIV seroprevalence surveys among patients with tuberculosis will enable investigators to determine the full extent to which HIV is responsible for the increase in tuberculosis morbidity.

Because increases in tuberculosis were also observed among foreign-born persons, Asians/Pacific Islanders, and females, factors other than HIV infection probably contributed to the increased morbidity in 1986. As reported previously, Hispanics and Asians/Pacific Islanders recently arriving in the United States are at high risk for tuberculosis. The number of these patients in younger age groups suggests that many cases among these populations are potentially preventable (*6,7*).

To reverse the current trend of increasing tuberculosis morbidity, both a more aggressive search for cases and the use of preventive therapy among high-risk populations will be necessary. Although all persons with tuberculous infection should be offered preventive therapy according to current guidelines (*8*), immigrants and refugees who have recently arrived from areas with a high prevalence of tuberculosis (*6*) and persons with HIV infection (*9*) should receive special attention.

Because HIV infection appears to be a significant risk factor for developing tuberculosis, CDC has recommended that HIV-infected individuals be given a tuberculin skin test (*9*). Although some HIV-infected persons may be anergic, a positive test is meaningful. Because of the risk of developing tuberculosis, HIV-infected persons who have or have had a positive tuberculin skin test should receive preventive therapy with isoniazid after active tuberculosis has been ruled out, regardless of their age. All patients with risk factors for tuberculosis and AIDS should be routinely counseled and tested for HIV antibody. HIV testing of other patients with tuberculosis should also be considered because of the implications of HIV seropositivity for patient management (*9*).

References

1. Centers for Disease Control. Tuberculosis – United States, 1985. MMWR 1986;35:699-703.
2. Centers for Disease Control. Tuberculosis and acquired immunodeficiency syndrome – New York City. MMWR 1987;36:785-90,795.
3. Centers for Disease Control. Tuberculosis and acquired immunodeficiency syndrome – Florida. MMWR 1986;35:587-90.
4. Rieder HL, Snider DE Jr, Witte JJ. Pulmonary tuberculosis and acquired immunodeficiency syndrome [Letter]. Chest 1987;92:383-4.
5. Pitchenik AE, Burr J, Suarez M, Fertel D, Gonzalez G, Moas C. Human T-cell lymphotrophic virus-III (HTLV-III) seropositivity and related disease among 71 consecutive patients in whom tuberculosis was diagnosed. Am Rev Respir Dis 1987;135:875-9.

Tuberculosis – Continued

6. Centers for Disease Control. Tuberculosis among Asians/Pacific Islanders—United States, 1985. MMWR 1987;36:331-4.
7. Centers for Disease Control. Tuberculosis among Hispanics—United States, 1985. MMWR 1987;36:568-9.
8. American Thoracic Society, Centers for Disease Control. Treatment of tuberculosis and tuberculosis infection in adults and children. Am Rev Respir Dis 1986;134:355-63.
9. Centers for Disease Control. Diagnosis and management of mycobacterial infection and disease in persons with human T-lymphotropic virus type III/lymphadenopathy-associated virus infection. MMWR 1986;35:448-52.

CENTERS FOR DISEASE CONTROL

April 1, 1988 / Vol. 37 / No. S-4

MMWR

Supplement

MORBIDITY AND MORTALITY WEEKLY REPORT

1988 Agent Summary Statement for Human Immunodeficiency Virus

and

Report on Laboratory-Acquired Infection with Human Immunodeficiency Virus

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control
Center for Infectious Diseases
Hospital Infections Program
AIDS Program
Atlanta, Georgia

A6-77

Supplements to the *MMWR* are published by the Epidemiology Program Office, Centers for Disease Control, Public Health Service, U.S. Department of Health and Human Services, Atlanta, Georgia 30333.

SUGGESTED CITATION

Centers for Disease Control. 1988 Agent summary statement for human immunodeficiency virus and Report on laboratory-acquired infection with human immunodeficiency virus. *MMWR* 1988;37(suppl. no. S-4):[inclusive page numbers].

Table of Contents

Agent Summary Statement for Human Immunodeficiency Viruses (HIVs) Including HTLV-III, LAV, HIV-1, and HIV-2*

INTRODUCTION

In 1984, the Centers for Disease Control (CDC) and the National Institutes of Health (NIH), in consultation with experts from academic institutions, industry, and government, published the book *Biosafety in Microbiological and Biomedical Laboratories* ("*Guidelines*")† (*1*).

These *Guidelines* are based on combinations of standard and special practices, equipment, and facilities recommended for use in working with infectious agents in various laboratory settings. The recommendations are advisory; they provide a general code for operating microbiologic and biomedical laboratories.

One section of the *Guidelines* is devoted to standard and special microbiologic practices, safety equipment, and facilities for biosafety levels (BSL) 1 through 4. Another section contains specific agent summary statements, each consisting of a brief description of laboratory-associated infections, the nature of laboratory hazards, and recommended precautions for working with the causative agent. The authors realized that the discovery of the availability of information about these agents would necessitate updating the agent summary. Such a statement for human immunodeficiency virus (HIV) (called HTLV-III/LAV when the *Guidelines* were published) was published in *MMWR* in 1986 (*2*). The HIV agent summary statement printed in this *Supplement* updates the 1986 statement.

Attached to the updated HIV agent summary statement are the essential elements for BSL 2 and 3 laboratories, reproduced from the *Guidelines* (*1*) (see Addendum 1, p. 6). BSL 2 and 3 laboratory descriptions are included because they are recommended for laboratory personnel working with HIV, depending on the concentration or quantity of virus or the type of laboratory procedures used.

*The information and recommendations contained in this document were developed and compiled by the Division of Safety, National Institute of Allergy and Infectious Diseases, the National Cancer Institute, and the Clinical Center of the National Institutes of Health; Food and Drug Administration; and the following CDC units: AIDS Program, Hospital Infections Program, Office of the Director, Center for Infectious Diseases; the Training and Laboratory Program Office; and the Office of Biosafety, Office of the Centers Director; Representatives of the following organizations also collaborated in the effort: the American Academy of Microbiology, the American Biological Safety Association, the American Society for Microbiology, the American Society for Clinical Pathology, the Association of State and Territorial Public Health Laboratory Directors, the College of American Pathologists, the Pharmaceutical Manufacturers Association, and the Walter Reed Army Institute for Research.

†Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, Stock #01702300167-1; or from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, Stock #PB84-206879.

The HIV agent summary statement does not specifically address safety measures for collecting and handling clinical specimens. Nonetheless, it has been recommended that blood and body-fluid precautions consistently be used for **ALL** specimens from **ALL** patients. This approach, referred to as "universal blood and body-fluid precautions" or "universal precautions," eliminates the need to identify all patients infected with HIV (or other bloodborne pathogens) (*3*). This subject is also covered in other publications (*3-8*).

Laboratory directors, supervisors, and others are asked to attach a copy of this revised "1988 Agent Summary Statement for Human Immunodeficiency Virus" to each copy of the *Guidelines* and to all copies of their laboratory biosafety manual; they should review the recommended precautions with laboratory personnel, provide appropriate training in practices and operation of facilities, and ensure that all personnel demonstrate proficiency **BEFORE** being allowed to work with HIV. The laboratory director (or the designated laboratory supervisor) is responsible for biosafety in the laboratory and must establish and implement practices, facilities, equipment, training, and work assignments as appropriate (*9*).

HIV AGENT SUMMARY STATEMENT

Agent: HIVs Including HTLV-III, LAV, HIV-1, and HIV-2

In the period 1984-1986, several health-care workers (HCWs) who had no recognized risk behavior for acquired immunodeficiency syndrome (AIDS) were reported to have HIV infection (*10-15*). Only one of these HCWs was identified as a laboratory worker. These and other reports assessed the risk of work-related HIV infection for all HCWs as being very low (*3,6,10-12,14-18*).

In 1985, anecdotal reports were received indicating that workers in two different HIV-reagent-production laboratories had been exposed to droplets and splashed liquid from a vessel containing concentrated virus. One of several workers had been cut by glass from a broken carboy that contained HIV-infected cells and medium. None of the persons exposed in these episodes had developed antibody to HIV or had clinical signs of infection 18 and 20 months, respectively, after the reported exposure.

In 1987, CDC received reports that three HCWs had HIV infection; none of the infections were associated with needlesticks or cuts. Two of these HCWs were clinical laboratory workers (*11*). One was a phlebotomist whose face and mouth were splattered with a patient's blood when the rubber stopper was suddenly expelled from a blood-collection tube. The second was a medical technologist who inadvertently spilled blood on her arms and forearms while using an apheresis apparatus to process blood from an HIV-seropositive patient.

In September 1987, a production-laboratory worker was reported to have HIV infection (*18*). This person worked with large concentrations of HIV in a BSL 3 facility. HIV was isolated from the worker's blood; the isolate was genetically indistinguishable from the strain of virus being cultivated in the laboratory. No risk factors were identified, and the worker recalled no specific incident that might have led to infection. However, there were instances of leakage of virus-positive culture fluid from equipment and contamination of the work area and centrifuge rotors. The report

concluded that the most plausible source of exposure was contact of the worker's gloved hand with virus-culture supernatant, followed by inapparent exposure to skin.

In October 1987, a second person who worked in another HIV production facility was reported to have HIV infection (*18*). This laboratory was a well-equipped BSL 3 facility, and BSL 3 practices were being followed. This worker reported having sustained a puncture wound to a finger while cleaning equipment used to concentrate HIV.

Laboratory Hazards

HIV has been isolated from blood, semen, saliva, tears, urine, cerebrospinal fluid, amniotic fluid, breast milk, cervical secretions, and tissue of infected persons and experimentally infected nonhuman primates. In the laboratory, virus should be presumed to be present in all HIV cultures, in all materials derived from HIV cultures, and in/on all equipment and devices coming into direct contact with any of these materials.

In the laboratory, the skin (especially when scratches, cuts, abrasions, dermatitis, or other lesions are present) and mucous membranes of the eye, nose, mouth, and possibly the respiratory tract should be considered as potential pathways for entry of virus. Needles, sharp instruments, broken glass, and other sharp objects must be carefully handled and properly discarded. Care must be taken to avoid spilling and splashing infected cell-culture liquid and other virus-containing materials.

Recommended Precautions

1. BSL 2 standards and special practices, containment equipment, and facilities, as described in the CDC-NIH publication *Biosafety in Microbiological and Biomedical Laboratories* (*Guidelines*), are recommended for activities involving all clinical specimens, body fluids, and tissues from humans or from infected or inoculated laboratory animals. These are the same standards and practices recommended for handling all clinical specimens. For example, and for emphasis:
   a. Use of syringes, needles, and other sharp instruments should be avoided if possible. Used needles and disposable cutting instruments should be discarded into a puncture-resistant container with a lid. Needles should not be re-sheathed, bent, broken, removed from disposable syringes, or otherwise manipulated by hand.
   b. Protective gloves should be worn by all personnel engaged in activities that may involve direct contact of skin with potentially infectious specimens, cultures, or tissues. Gloves should be carefully removed and changed when they are visibly contaminated. Personnel who have dermatitis or other lesions on the hands and who may have indirect contact with potentially infectious material should also wear protective gloves. Hand washing with soap and water immediately after infectious materials are handled and after work is completed—**EVEN WHEN GLOVES HAVE BEEN WORN** as described above—should be a routine practice.
   c. Generation of aerosols, droplets, splashes, and spills should be avoided. A biological safety cabinet should be used for all procedures that might generate aerosols or droplets and for all infected cell-culture manipulations. The *Guidelines* (pp. 11-13) contain additional precautions for operating at BSL 2.

2. Activities such as producing research-laboratory-scale amounts of HIV, manipulating concentrated virus preparations, and conducting procedures that may produce aerosols or droplets should be performed in a BSL 2 facility with the additional practices and containment equipment recommended for BSL 3 (*19*) (*Guidelines,* pp. 14-17).
3. Activities involving industrial-scale, large-volume production or high concentration and manipulation of concentrated HIV should be conducted in a BSL 3 facility using BSL 3 practices and equipment (*19*).
4. BSL 2 practices, containment equipment, and facilities for animals are recommended for activities involving nonhuman primates and any animals experimentally infected or inoculated with HIV. Because laboratory animals may bite, throw feces or urine, or expectorate at humans, animal-care personnel, investigators, technical staff, and other persons who enter the animal rooms should wear coats, protective gloves, coveralls or uniforms, and—as appropriate—face shields or surgical masks and eye shields to protect the skin and mucous membranes of the eyes, nose, and mouth.
5. All laboratory glassware, disposable material, and waste material suspected or known to contain HIV should be decontaminated, preferably in an autoclave, before it is washed, discarded, etc. An alternate method of disposing of solid wastes is incineration.
6. Laboratory workers should wear laboratory coats, gowns, or uniforms when working with HIV or with material known or suspected to contain HIV. There is no evidence that laboratory clothing poses a risk for HIV transmission; however, clothing that becomes contaminated with HIV preparations should be decontaminated before being laundered or discarded. Laboratory personnel must remove laboratory clothing before going to nonlaboratory areas.
7. Work surfaces should be decontaminated with an appropriate chemical germicide after procedures are completed, when surfaces are overtly contaminated, and at the end of each work day. Many commercially available chemical disinfectants (*5,20-23*) can be used for decontaminating laboratory work surfaces, for some laboratory instruments, for spot cleaning of contaminated laboratory clothing, and for spills of infectious materials. Prompt decontamination of spills should be standard practice.
8. Universal precautions are recommended for handling all human blood specimens for hematologic, microbiologic, chemical, serologic testing; these are the same precautions for preventing transmission of all bloodborne infections including hepatitis B (*17,21,24,25*). It is not certain how effective 56 C-60 C heat is in destroying HIV in serum (*22,23,26*), but heating small volumes of serum for 30 minutes at 56 C before serologic testing reduces residual infectivity to below detectable levels. Such treatment causes some false-positive results in HIV enzyme immunoassays (*27-30*) and may also affect some biochemical assays performed on serum (*27,31,32*).
9. Human serum from any source that is used as a control or reagent in a test procedure should be handled at BSL 2 (*Guidelines,* pp. 11-13). Addendum 2 (p. 16) to this report is a statement issued by CDC on the use of all human control and reagent serum specimens shipped to other laboratories. The Food and Drug Administration requires that manufacturers of human serum reagents use a similarly worded statement.

10. Medical surveillance programs should be in place in all laboratories that test specimens, do research, or produce reagents involving HIV. The nature and scope of a surveillance program will vary according to institutional policy and applicable local, state, and Federal regulations (*9*).
11. If a laboratory worker has a parenteral or mucous-membrane exposure to blood, body fluid, or viral-culture material, the source material should be identified and, if possible, tested for the presence of virus. If the source material is positive for HIV antibody, virus, or antigen, or is not available for examination, the worker should be counseled regarding the risk of infection and should be evaluated clinically and serologically for evidence of HIV infection. The worker should be advised to report on and to seek medical evaluation of any acute febrile illness that occurs within 12 weeks after the exposure (*3*). Such an illness—particularly one characterized by fever, rash, or lymphadenopathy—may indicate recent HIV infection. If seronegative, the worker should be retested 6 weeks after the exposure and periodically thereafter (e.g., at 12 weeks and 6 months after exposure). During this follow-up period—especially during the first 6-12 weeks after exposure, when most infected persons are expected to show serologic evidence of infection—exposed workers should be counseled to follow Public Health Service recommendations for preventing transmission of HIV (*3,14,25,33*). It is recommended that all institutions establish written policies regarding the management of laboratory exposure to HIV; such policies should deal with confidentiality, counseling, and other related issues.
12. Other primary and opportunistic pathogenic agents may be present in the body fluids and tissues of persons infected with HIV. Laboratory workers should follow accepted biosafety practices to ensure maximum protection against inadvertent laboratory exposure to agents that may also be present in clinical specimens (*34-36*).
13. Unless otherwise dictated by institutional policy, the laboratory director (or designated laboratory supervisor) is responsible for carrying out the biosafety program in the laboratory. In this regard, the laboratory director or designated supervisor should establish the biosafety level for each component of the work to be done and should ensure that facilities and equipment are adequate and in good working order, that appropriate initial and periodic training is provided to the laboratory staff, and that recommended practices and procedures are strictly followed (*9*).
14. Attention is directed to a "Joint Advisory Notice" of the Departments of Labor and Health and Human Services (*9*) that describes the responsibility of employers to provide "safe and healthful working conditions" to protect employees against occupational infection with HIV. The notice defines three exposure categories of generic job-related tasks and describes the protective measures required for employees involved in each exposure category. These measures are: administrative measures, training and education programs for employees, engineering controls, work practices, medical and health-care practices, and record-keeping. The recommendations in this report are consistent with the "Joint Advisory Notice"; managers/directors of all biomedical laboratories are urged to read this notice.

ADDENDUM 1

LABORATORY BIOSAFETY LEVEL CRITERIA

Biosafety Level 2

Biosafety Level 2 is similar to Level 1 and is suitable for work involving agents that represent a moderate hazard for personnel and the environment. It differs in that a) laboratory personnel have specific training in handling pathogenic agents and are directed by competent scientists, b) access to the laboratory is limited when work is being conducted, and c) certain procedures in which infectious aerosols are created are conducted in biological safety cabinets or other physical containment equipment.

The following standard and special practices, safety equipment, and facilities apply to agents assigned to Biosafety Level 2:

A. Standard microbiological practices

1. Access to the laboratory is limited or restricted by the laboratory director when work with infectious agents is in progress.
2. Work surfaces are decontaminated at least once a day and after any spill of viable material.
3. All Infectious liquid or solid waste is decontaminated before being disposed of.
4. Mechanical pipetting devices are used; mouth pipetting is prohibited.
5. Eating, drinking, smoking, and applying cosmetics are not permitted in the work area. Food must be stored in cabinets or refrigerators designed and used for this purpose only. Food storage cabinets or refrigerators should be located outside the work area.
6. Persons are to wash their hands when they leave the laboratory after handling infectious material or animals.
7. All procedures are performed carefully to minimize the creation of aerosols.

B. Special practices

1. Contaminated materials that are to be decontaminated away from the laboratory are placed in a durable, leakproof container that is closed before being removed from the laboratory.
2. The laboratory director limits access to the laboratory. In general, persons who are at increased risk of acquiring infection or for whom infection may be unusually hazardous are not allowed in the laboratory or animal rooms. The director has the final responsibility for assessing each circumstance and determining who may enter or work in the laboratory.
3. The laboratory director establishes policies or procedures whereby only persons who have been advised of the potential hazard and who meet any specific entry requirements (e.g., vaccination) enter the laboratory or animal rooms.
4. When an infectious agent being worked with in the laboratory requires special provisions for entry (e.g., vaccination), a hazard warning sign that incorporates the universal biohazard symbol is posted on the access door to the laboratory work area. The hazard warning sign identifies the infec-

tious agent, lists the name and telephone number of the laboratory director or other responsible person(s), and indicates the special requirement(s) for entering the laboratory.

5. An insect and rodent control program is in effect.
6. Laboratory coats, gowns, smocks, or uniforms are worn while in the laboratory. Before leaving the laboratory for nonlaboratory areas (e.g., cafeteria, library, administrative offices), this protective clothing is removed and left in the laboratory or covered with a clean coat not used in the laboratory.
7. Animals not involved in the work being performed are not permitted in the laboratory.
8. Special care is taken to avoid having skin be contaminated with infectious material; gloves should be worn when handling infected animals and when skin contact with infectious material is unavoidable.
9. All waste from laboratories and animal rooms is appropriately decontaminated before disposal.
10. Hypodermic needles and syringes are used only for parenteral injection and aspiration of fluids from laboratory animals and diaphragm bottles. Only needle-locking syringes or disposable syringe-needle units (i.e., the needle is integral to the syringe) are used for the injection or aspiration of infectious fluid. Extreme caution should be used when handling needles and syringes to avoid autoinoculation and the generation of aerosols during use and disposal. A needle should not be bent, sheared, replaced in the sheath or guard, or removed from the syringe following use. The needle and syringe should be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before discard or reuse.
11. Spills and accidents that result in overt exposures to infectious material are immediately reported to the laboratory director. Medical evaluation, surveillance, and treatment are provided as appropriate, and written records are maintained.
12. When appropriate, considering the agent(s) handled, baseline serum samples for laboratory and other at-risk personnel are collected and stored. Additional serum specimens may be collected periodically, depending on the agents handled or on the function of the facility.
13. A biosafety manual is prepared or adopted. Personnel are advised of special hazards and are required to read instructions on practices and procedures and to follow them.

C. Containment equipment

Biological safety cabinets (Class I or II) or other appropriate personal-protection or physical-containment devices are used when:

1. Procedures with a high potential for creating infectious aerosols are conducted. These may include centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, opening containers of infectious materials whose internal pressures may be different from ambient pressures, inoculating animals intranasally, and harvesting infected tissues from animals or eggs.
2. High concentrations or large volumes of infectious agents are used. Some types of materials may be centrifuged in the open laboratory if sealed heads

or centrifuge safety cups are used and if the containers are opened only in a biological safety cabinet.

D. Laboratory facilities

1. The laboratory is designed so that it can be easily cleaned.
2. Bench tops are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.
3. Laboratory furniture is sturdy, and spaces between benches, cabinets, and equipment are accessible for cleaning.
4. Each laboratory contains a sink for hand washing.
5. If the laboratory has windows that open, they are fitted with fly screens.
6. An autoclave for decontaminating infectious laboratory wastes is available.

Biosafety Level 3

Biosafety Level 3 is applicable to clinical, diagnostic, teaching, research, or production facilities in which work is done with indigenous or exotic agents that may cause serious or potentially lethal disease as a result of exposure by inhalation. Laboratory personnel have specific training in handling pathogenic and/or potentially lethal agents and are supervised by competent scientists who are experienced in working with these agents. All procedures involving the manipulation of infectious material are conducted within biological safety cabinets or other physical containment devices or by personnel wearing appropriate personal-protection clothing and devices. The laboratory has special engineering and design features. It is recognized, however, that many existing facilities may not have all the facility safeguards recommended for Biosafety Level 3 (e.g., access zone, sealed penetrations, and directional airflow). In these circumstances, acceptable safety may be achieved for routine or repetitive operations (e.g., diagnostic procedures involving the propagation of an agent for identification, typing, and susceptibility testing) in laboratories in which facility features satisfy Biosafety Level 2 recommendations if the recommended "Standard Microbiological Practices," "Special Practices," and "Containment Equipment" for Biosafety Level 3 are rigorously followed. The decision to implement this modification of Biosafety Level 3 recommendations should be made only by the laboratory director.

The following standard and special safety practices, equipment, and facilities apply to agents assigned to Biosafety Level 3:

A. Standard microbiological practices

1. Work surfaces are decontaminated at least once a day and after any spill of viable material.
2. All infectious liquid or solid waste is decontaminated before being disposed of.
3. Mechanical pipetting devices are used; mouth pipetting is prohibited.
4. Eating, drinking, smoking, storing food, and applying cosmetics are not permitted in the work area.
5. Persons wash their hands after handling infectious materials and animals and every time they leave the laboratory.
6. All procedures are performed carefully to minimize the creation of aerosols.

B. Special practices

1. Laboratory doors are kept closed when experiments are in progress.

2. Contaminated materials that are to be decontaminated at a site away from the laboratory are placed in a durable, leakproof container that is closed before being removed from the laboratory.
3. The laboratory director controls access to the laboratory and limits access only to persons whose presence is required for program or support purposes. Persons who are at increased risk of acquiring infection or for whom infection may be unusually hazardous are not allowed in the laboratory or animal rooms. The director has the final responsibility for assessing each circumstance and determining who may enter or work in the laboratory.
4. The laboratory director establishes policies and procedures whereby only persons who have been advised of the potential biohazard, who meet any specific entry requirements (e.g., vaccination), and who comply with all entry and exit procedures enter the laboratory or animal rooms.
5. When infectious materials or infected animals are present in the laboratory or containment module, a hazard warning sign (incorporating the universal biohazard symbol) is posted on all laboratory and animal-room access doors. The hazard warning sign identifies the agent, lists the name and telephone number of the laboratory director or other responsible person(s), and indicates any special requirements for entering the laboratory, such as the need for vaccinations, respirators, or other personal-protection measures.
6. All activities involving infectious materials are conducted in biological safety cabinets or other physical-containment devices within the containment module. No work is conducted in open vessels on the open bench.
7. The work surfaces of biological safety cabinets and other containment equipment are decontaminated when work with infectious materials is finished. Plastic-backed paper toweling used on nonperforated work surfaces within biological safety cabinets facilitates clean-up.
8. An insect and rodent control program is in effect.
9. Laboratory clothing that protects street clothing (e.g., solid-front or wrap-around gowns, scrub suits, coveralls) is worn in the laboratory. Laboratory clothing is not worn outside the laboratory, and it is decontaminated before being laundered.
10. Special care is taken to avoid skin contamination with infectious materials; gloves are worn when handling infected animals and when skin contact with infectious materials is unavoidable.
11. Molded surgical masks or respirators are worn in rooms containing infected animals.
12. Animals and plants not related to the work being conducted are not permitted in the laboratory.
13. All waste from laboratories and animal rooms is appropriately decontaminated before being disposed of.
14. Vacuum lines are protected with high-efficiency particulate air (HEPA) filters and liquid disinfectant traps.
15. Hypodermic needles and syringes are used only for parenteral injection and aspiration of fluids from laboratory animals and diaphragm bottles. Only needle-locking syringes or disposable syringe-needle units (i.e., the needle

is integral to the syringe) are used for the injection or aspiration of infectious fluids. Extreme caution is used when handling needles and syringes to avoid autoinoculation and the generation of aerosols during use and disposal. A needle should not be bent, sheared, replaced in the sheath or guard, or removed from the syringe following use. The needle and syringe should be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before being discarded or reused.

16. Spills and accidents that result in overt or potential exposures to infectious material are immediately reported to the laboratory director. Appropriate medical evaluation, surveillance, and treatment are provided, and written records are maintained.
17. Baseline serum samples for all laboratory and other at-risk personnel are collected and stored. Additional serum specimens may be collected periodically, depending on the agents handled or the function of the laboratory.
18. A biosafety manual is prepared or adopted. Personnel are advised of special hazards and are required to read instructions on practices and procedures and to follow them.

C. Containment equipment

Biological safety cabinets (Class I, II, or III) or other appropriate combinations of personal-protection or physical-containment devices (e.g., special protective clothing, masks, gloves, respirators, centrifuge safety cups, sealed centrifuge rotors, and containment caging for animals) are used for all activities with infectious materials that pose a threat of aerosol exposure. These include: manipulation of cultures and of clinical or environmental material that may be a source of infectious aerosols; the aerosol challenge of experimental animals; harvesting of tissues or fluids from infected animals and embryonated eggs; and necropsy of infected animals.

D. Laboratory facilities

1. The laboratory is separated from areas that are open to unrestricted traffic flow within the building. Passage through two sets of doors is the basic requirement for entry into the laboratory from access corridors or other contiguous areas. Physical separation of the high-containment laboratory from access corridors or other laboratories or activities may also be provided by a double-doored clothes-change room (showers may be included), airlock, or other access facility that requires passing through two sets of doors before entering the laboratory.
2. The interior surfaces of walls, floors, and ceilings are water resistant so that they can be easily cleaned. Penetrations in these surfaces are sealed or capable of being sealed to facilitate decontaminating the area.
3. Bench tops are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.
4. Laboratory furniture is sturdy, and spaces between benches, cabinets, and equipment are accessible for cleaning.
5. Each laboratory contains a sink for washing hands. The sink is foot, elbow, or automatically operated and is located near the laboratory exit door.
6. Windows in the laboratory are closed and sealed.
7. Access doors to the laboratory or containment module are self-closing.

8. An autoclave for decontaminating laboratory wastes is available, preferably within the laboratory.
9. A ducted exhaust-air ventilation system is provided. This system creates directional airflow that draws air into the laboratory through the entry area. The exhaust air is not recirculated to any other area of the building, is discharged to the outside, and is dispersed away from occupied areas and air intakes. Personnel must verify that the direction of the airflow is proper (i.e., into the laboratory). The exhaust air from the laboratory room can be discharged to the outside without being filtered or otherwise treated.
10. The HEPA-filtered exhaust air from Class I or CLass II biological safety cabinets is discharged directly to the outside or through the building exhaust system. Exhaust air from Class I or II biological safety cabinets may be recirculated within the laboratory if the cabinet is tested and certified at least every 12 months. If the HEPA-filtered exhaust air from Class I or II biological safety cabinets is to be discharged to the outside through the building exhaust system, it is connected to this system in a manner (e.g., thimble-unit connection) that avoids any interference with the air balance of the cabinets or building exhaust system.

VERTEBRATE ANIMAL BIOSAFETY LEVEL CRITERIA

Animal Biosafety Level 2

A. Standard practices

1. Doors to animal rooms open inward, are self-closing, and are kept closed when infected animals are present.
2. Work surfaces are decontaminated after use or spills of viable materials.
3. Eating, drinking, smoking, and storing of food for human use are not permitted in animal rooms.
4. Personnel wash their hands after handling cultures and animals and before leaving the animal room.
5. All procedures are carefully performed to minimize the creation of aerosols.
6. An insect and rodent control program is in effect.

B. Special practices

1. Cages are decontaminated, preferably by autoclaving, before being cleaned and washed.
2. Surgical-type masks are worn by all personnel entering animal rooms housing nonhuman primates.
3. Laboratory coats, gowns, or uniforms are worn while in the animal room. This protective clothing is removed before leaving the animal facility.
4. The laboratory or animal-facility director limits access to the animal room only to personnel who have been advised of the potential hazard and who need to enter the room for program or service purposes when work is in progress. In general, persons who may be at increased risk of acquiring

infection or for whom infection might be unusually hazardous are not allowed in the animal room.

5. The laboratory or animal-facility director establishes policies and procedures whereby only persons who have been advised of the potential hazard and who meet any specific requirements (e.g., vaccination) may enter the animal room.
6. When an infectious agent in use in the animal room requires special-entry provisions (e.g., vaccination), a hazard warning sign (incorporating the universal biohazard symbol) is posted on the access door to the animal room. The hazard warning sign identifies the infectious agent, lists the name and telephone number of the animal-facility supervisor or other responsible person(s), and indicates the special requirement(s) for entering the animal room.
7. Special care is taken to avoid contaminating skin with infectious material; gloves should be worn when handling infected animals and when skin contact with infectious materials is unavoidable.
8. All waste from the animal room is appropriately decontaminated—preferably by autoclaving—before being disposed of. Infected animal carcasses are incinerated after being transported from the animal room in leakproof, covered containers.
9. Hypodermic needles and syringes are used only for the parenteral injection or aspiration of fluids from laboratory animals and diaphragm bottles. Only needle-locking syringes or disposable syringe-needle units (i.e., the needle is integral to the syringe) are used for the injection or aspiration of infectious fluids. A needle should not be bent, sheared, replaced in the sheath or guard, or removed from the syringe following use. The needle and syringe should be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before being discarded or reused.
10. If floor drains are provided, the drain taps are always filled with water or a suitable disinfectant.
11. When appropriate, considering the agents handled, baseline serum samples from animal-care and other at-risk personnel are collected and stored. Additional serum samples may be collected periodically, depending on the agents handled or the function of the facility.

C. Containment equipment

Biological safety cabinets, other physical-containment devices, and/or personal-protection devices (e.g., respirators, face shields) are used when procedures with a high potential for creating aerosols are conducted. These include necropsy of infected animals, harvesting of infected tissues or fluids from animals or eggs, intranasal inoculation of animals, and manipulation of high concentrations or large volumes of infectious materials.

D. Animal facilities

1. The animal facility is designed and constructed to facilitate cleaning and housekeeping.
2. A sink for washing hands is available in the room that houses infected animals.
3. If the animal facility has windows that open, they are fitted with fly screens.

4. It is recommended, but not required, that the direction of airflow in the animal facility is inward and that exhaust air is discharged to the outside without being recirculated to other rooms.
5. An autoclave that can be used for decontaminating infectious laboratory waste is available in the same building that contains the animal facility.

Animal Biosafety Level 3

A. Standard practices

1. Doors to animal rooms open inward, are self-closing, and are kept closed when work with infected animals is in progress.
2. Work surfaces are decontaminated after use or after spills of viable materials.
3. Eating, drinking, smoking, and storing of food for human use are not permitted in the animal room.
4. Personnel wash their hands after handling cultures or animals and before leaving the laboratory.
5. All procedures are carefully performed to minimize the creation of aerosols.
6. An insect and rodent control program is in effect.

B. Special practices

1. Cages are autoclaved before bedding is removed and before they are cleaned and washed.
2. Surgical-type masks or other respiratory protection devices (e.g., respirators) are worn by personnel entering rooms that house animals infected with agents assigned to Biosafety Level 3.
3. Wrap-around or solid-front gowns or uniforms are worn by personnel entering the animal room. Front-button laboratory coats are unsuitable. Protective gowns must remain in the animal room and must be decontaminated before being laundered.
4. The laboratory director or other responsible person limits access to the animal room only to personnel who have been advised of the potential hazard and who need to enter the room for program or service purposes when infected animals are present. In general, persons who may be at increased risk of acquiring infection or for whom infection might be unusually hazardous are not allowed in the animal room.
5. The laboratory director or other responsible person establishes policies and procedures whereby only persons who have been advised of the potential hazard and meet any specific requirements (e.g., vaccination) may enter the animal room.
6. Hazard warning signs (incorporating the universal biohazard warning symbol) are posted on access doors to animal rooms containing animals infected with agents assigned to Biosafety Level 3 are present. The hazard warning sign should identify the agent(s) in use, list the name and telephone number of the animal room supervisor or other responsible person(s), and indicate any special conditions of entry into the animal room (e.g., the need for vaccinations or respirators).
7. Personnel wear gloves when handling infected animals. Gloves are removed aseptically and autoclaved with other animal room waste before being disposed of or reused.

8. All wastes from the animal room are autoclaved before being disposed of. All animal carcasses are incinerated. Dead animals are transported from the animal room to the incinerator in leakproof, covered containers.
9. Hypodermic needles and syringes are used only for gavage or parenteral injection or aspiration of fluids from laboratory animals and diaphragm bottles. Only needle-locking syringes or disposable syringe-needle units (i.e., the needle is integral to the syringe) are used. A needle should not be bent, sheared, replaced in the sheath or guard, or removed from the syringe following use. The needle and syringe should be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before being discarded or reused. When possible, cannulas should be used instead of sharp needles (e.g., gavage).
10. If floor drains are provided, the drain traps are always filled with water or a suitable disinfectant.
11. If vacuum lines are provided, they are protected with HEPA filters and liquid disinfectant traps.
12. Boots, shoe covers, or other protective footwear and disinfectant footbaths are available and used when indicated.

C. Containment equipment

1. Personal-protection clothing and equipment and/or other physical-containment devices are used for all procedures and manipulations of infectious materials or infected animals.
2. The risk of infectious aerosols from infected animals or their bedding can be reduced if animals are housed in partial-containment caging systems, such as open cages placed in ventilated enclosures (e.g., laminar-flow cabinets), solid-wall and -bottom cages covered by filter bonnets, or other equivalent primary containment systems.

D. Animal facilities

1. The animal facility is designed and constructed to facilitate cleaning and housekeeping and is separated from areas that are open to unrestricted personnel traffic within the building. Passage through two sets of doors is the basic requirement for entry into the animal room from access corridors or other contiguous areas. Physical separation of the animal room from access corridors or from other activities may also be provided by a double-doored clothes change room (showers may be included), airlock, or other access facility that requires passage through two sets of doors before entering the animal room.
2. The interior surfaces of walls, floors, and ceilings are water resistant so that they can be cleaned easily. Penetrations in these surfaces are sealed or capable of being sealed to facilitate fumigation or space decontamination.
3. A foot, elbow, or automatically operated sink for hand washing is provided near each animal-room exit door.
4. Windows in the animal room are closed and sealed.
5. Animal room doors are self-closing and are kept closed when infected animals are present.
6. An autoclave for decontaminating wastes is available, preferably within the animal room. Materials to be autoclaved outside the animal room are transported in a covered, leakproof container.

7. An exhaust-air ventilation system is provided. This system creates directional airflow that draws air into the animal room through the entry area. The building exhaust can be used for this purpose if the exhaust air is not recirculated to any other area of the building, is discharged to the outside, and is dispersed away from occupied areas and air intakes. Personnel must verify that the direction of the airflow is proper (i.e., into the animal room). The exhaust air from the animal room that does not pass through biological safety cabinets or other primary containment equipment can be discharged to the outside without being filtered or otherwise treated.
8. The HEPA-filtered exhaust air from Class I or Class II biological safety cabinets or other primary containment devices is discharged directly to the outside or through the building's exhaust system. Exhaust air from these primary containment devices may be recirculated within the animal room if the cabinet is tested and certified at least every 12 months. If the HEPA-filtered exhaust air from Class I or Class II biological safety cabinets is discharged to the outside through the building exhaust system, it is connected to this system in a manner (e.g., thimble-unit connection) that avoids any interference with the air balance of the cabinets or building exhaust system.

ADDENDUM 2

CDC cautionary notice for all human-serum-derived reagents used as controls:

> **WARNING:** Because no test method can offer complete assurance that laboratory specimens do not contain HIV, hepatitis B virus, or other infectious agents, this specimen should be handled at the BSL 2 as recommended for any potentially infectious human serum or blood specimen in the CDC-NIH manual, *Biosafety in Microbiological and Biomedical Laboratories,* 1984, pages 11-13.

If additional statements describing the results of any heat treatment or serologic procedure(s) already performed on the human-serum reagent or control are used in conjunction with the above cautionary notice, these statements should be worded so as not to diminish the impact of the warning that emphasizes the need for universal precautions.

References

1. Richardson JH, Barkley WE, eds. Biosafety in microbiological and biomedical laboratories, 1984. Washington, DC: Public Health Service, 1984; DHHS publication no. (CDC)84-8395.
2. CDC. Human T-lymphotropic virus type III/lymphadenopathy-associated virus agent summary statement. MMWR 1986;35:540-2, 547-9.
3. CDC. Recommendations for prevention of HIV transmission in health-care settings. MMWR 1987;36(suppl 2):3S-18S.
4. Isenberg HD, Washington JA, Balows A, Sonnenwirth AC. Collection, handling and processing of specimens. In: Lennette EH, Balows A, Hausler WJ, Shadomy HJ, eds. Manual of clinical microbiology, 4th ed. Washington, DC: American Society for Microbiology, 1985:73-98.
5. CDC. Acquired immune deficiency syndrome (AIDS): precautions for clinical and laboratory workers. MMWR 1982;32:577-80.
6. CDC. Recommendations for preventing transmission of infection with human T-lymphotropic virus type III/lymphadenopathy-associated virus in the workplace. MMWR 1985;34:681.
7. CDC. Recommendations for preventing transmission of infection with human T-lymphotropic virus type III/lymphadenopathy-associated virus during invasive procedures. MMWR 1986;35:221-3.
8. CDC. Recommendations for preventing transmission of infection with human T-lymphotropic virus type III/lymphadenopathy-associated virus in the workplace. MMWR 1985;34:682-6, 691-5.
9. U.S. Department of Health and Human Services, Public Health Service. Joint advisory notice: HBV/HIV. Federal Register 1987;52 (October 30): 41818-24.
10. CDC. Update: evaluation of human T-lymphotropic virus type III/lymphadenopathy-associated virus infection in health-care personnel—United States. MMWR 1985;34:575-8.
11. CDC. Human immunodeficiency virus infections in health-care workers exposed to blood of infected patients. MMWR 1987;36:285-9.
12. Anonymous. Needlestick transmission of HTLV-III from a patient infected in Africa. Lancet 1984;2:1376-7.
13. Stricof RL, Morse DL. HTLV-III/LAV seroconversion following a deep intramuscular needlestick injury. New Engl J Med 1986;314:1115.
14. McCray E, Cooperative Needlestick Study Group. Occupational risk of the acquired immunodeficiency syndrome among health-care workers. N Engl J Med 1986;314:1127-32.
15. Weiss SH, Saxinger WC, Richtman D, et al. HTLV-III infection among health-care workers: association with needlestick injuries. JAMA 1985;254:2089-93.

16. 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.
17. Gerberding JL, Bryant-Le Blanc 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.
18. Weiss SH, Goedert JJ, Gartner S, et al. Risk of human immunodeficiency virus (HIV-1) infection among laboratory workers. Science 1988;239:68-71.
19. U.S. Department of Health and Human Services, Public Health Service. Biosafety guidelines for use of HTLV-III and related viruses. Federal Register 1984 (October 16);49:40556.
20. U.S. Environmental Protection Agency. EPA guide for infectious waste management. Washington, DC: U.S. Environmental Protection Agency, 1986; Publication no. EPA/530-SW-86-014.
21. Favero MS. Sterilization, disinfection and antisepsis in the hospital. In: Lennette EH, Balows A, Hausler WJ, Shadomy HJ, eds. Manual of clinical microbiology, 4th ed. Washington, DC: American Society for Microbiology: 1985;129-37.
22. Martin LS, McDougal JS, Loskoski SL. Disinfection and inactivation of the human T lymphotropic virus type III/lymphadenopathy-associated virus. J Infect Dis 1985:152:400-3.
23. Resnick L, Veren K, Salahuddin, SZ, Tondreau S, Markham PD. Stability and inactivation of HTLV-III/LAV under clinical and laboratory environments. JAMA 1986;255:1887-91.
24. Favero MS, Petersen NJ, Bond WW. Transmission and control of laboratory-acquired hepatitis infection. In: Miller BM, Groschel DHM, Richardson JH, et al., eds. Laboratory safety: principles and practice. Washington, DC: American Society for Microbiology, 1986:49-58.
25. CDC. Public Health Service guidelines for counseling and antibody testing to prevent HIV infections and AIDS. MMWR 1987;36:509-15.
26. Ronalds CJ, Grint PCA, Kangro HD. Disinfection and inactivation of HTLV-III/LAV [Letter]. J Infect Dis 1986;153:996.
27. Evans RP, Shanson DC. Effect of heat on serologic tests for hepatitis B and syphilis and on aminoglycoside assays [Letter]. Lancet 1985;1:1458.
28. Van den Akker R, Hekker AC, Osterhaus ADME. Heat inactivation of serum may interfere with HTLV-III/LAV serology [Letter]. Lancet 1985;2:672.
29. Mortimer PP, Parry JV, Mortimer JY. Which anti-HTLV III/LAV assays for screening and confirmatory testing? Lancet 1985;2:873-7.
30. Jungkind DL, DiRenzo SA, Young SJ. Effect of using heat-inactivated serum with the Abbott human T-cell lymphotropic virus type III antibody test. J Clin Microbiol 1986;23:381-2.
31. Goldie DJ, McConnell AA, Cooke PR. Heat treatment of whole blood and serum before chemical analysis [Letter]. Lancet 1985;1:1161.
32. Lai L, Ball G, Stevens J, Shanson D. Effect of heat treatment of plasma and serum on biochemical indices [Letter]. Lancet 1985;1:1457-8.
33. CDC. Additional recommendations to reduce sexual and drug abuse-related transmission of human T-lymphotropic virus type III/lymphadenopathy-associated virus. MMWR 1986;35:152-5.
34. CDC. Revision of the case definition of acquired immunodeficiency syndrome for national reporting—United States. MMWR 1985;34:373-5.
35. CDC. Diagnosis and management of mycobacterial infection and disease in persons with human T-lymphotropic virus type III/lymphadenopathy-associated virus infection. MMWR 1986;35:448-52.
36. CDC. Revision of the CDC surveillance case definition for acquired immunodeficiency syndrome. MMWR 1987;36(suppl 1):1S-15S.

Occupationally Acquired Human Immunodeficiency Virus Infections in Laboratories Producing Virus Concentrates in Large Quantities:

Conclusions and Recommendations of an Expert Team Convened by the Director of the National Institutes of Health (NIH)

*Reported by Division of Safety, National Institutes of Health**

INTRODUCTION

The recommendations of the expert team are directed to industrial-scale facilities for the production of large quantities of highly concentrated HIV. Their recommendations are similar to and complement those in the preceding "1988 Agent Summary Statement for Human Immunodeficiency Virus," which updates the one published in 1986 (*1*). Laboratory directors and others responsible for the health and safety of laboratory employees working with HIV and HIV-containing material should carefully consider these relevant recommendations and guidelines in developing an appropriate safety program.

COMMITTEE REPORT

Two workers in different laboratories producing large quantities of highly concentrated HIV have been reported to have laboratory-acquired HIV infections (*1*). One worker's infection was presumed to be caused by "undetected skin contact with virus culture supernatant" (*2*). The other worker's infection followed "an injury with a potentially contaminated needle" (*2*). After the first case was identified, the Director of NIH convened a team of experts to investigate the incidents and to visit seven different laboratories that produced large volumes of HIV. After facilities inspections and separate, confidential interviews with the workers, the team prepared a report of their findings. The conclusions and recommendations from that report follow.

*Expert Team: W. Emmett Barkley, PhD, Director, Division of Engineering Services, National Institutes of Health; Robert McKinney, PhD, Director, Division of Safety, National Institutes of Health; John Richardson, DVM, MPH, Biosafety Officer, Emory University; Gerald Schochetman, PhD, Chief, Laboratory Investigations Branch, AIDS Program, Center for Infectious Diseases, Centers for Disease Control; David Henderson, MD, Hospital Epidemiologist, Warren Grant Magnuson Clinical Center, National Institutes of Health.

The most probable cause for the first laboratory-acquired infection was inapparent parenteral exposure. Frequent opportunities for unrecognized direct contact with contaminated materials and surfaces were reported to be present. Gloves of questionable integrity, skin cuts and abrasions, and one episode of a dermatitis-like condition represented portals for possible exposure and routes of infection. The inexperience of the first infected worker in microbiologic procedures and Biosafety Level (BSL) 3 practices, coupled with the reliance on obtaining necessary skills through on-the-job training in a setting in which episodes of contamination may have occurred frequently, suggests that the worker might not have possessed an appropriate level of proficiency when the infection may have occurred.

The most probable cause for the second worker's infection was parenteral inoculation. This worker recalled incurring an injury with a blunt cannula approximately 6 months before the first seropositive sample. Incidents of contamination, such as those reported by the first worker, occurred infrequently in the second worker's laboratory.

Aerosol transmission is considered to be the least likely cause of infection in both cases. Operations in which aerosols may have been generated were carried out in biological safety cabinets to reduce the potential for inhalation exposure. Although some aerosols may have been released during the few reported rotor-seal failures involving the continuous-flow zonal centrifuge, the potential for contact exposure was greater. Aerosol transmission was unlikely because: a) in situations in which overt aerosol exposure has occurred in laboratory and production operations involving HIV, no exposed workers have seroconverted; b) no evidence exists that suggests aerosols may be a natural mode of HIV transmission; c) the probable cause identified above is consistent with documented modes of transmission of bloodborne pathogens in the laboratory.

The occurrence of these two infections emphasizes the finite risk that exists for laboratory workers who handle concentrated preparations of HIV. The conclusions of a National Cancer Institute prospective cohort study (*2*) indicate that this risk is low and may be similar to the risk for infection of health-care workers who have experienced a needlestick injury.

The occupational risk for infection by parenteral exposure is substantially reduced or eliminated by strict adherence to BSL 2 practices. The recommended use of BSL 3 practices for highly concentrated preparations of HIV is appropriate. The review of these two infected laboratory workers does not suggest the need to alter current CDC/NIH biosafety recommendations for HIV or for patient care (*3*), research (*1*), or virus production. There is a need, however, for more proficiency and discipline in laboratory safety practices.

The following recommendations will help assure maintenance of a safe and healthy environment for laboratory and production-facility workers who handle concentrated preparations of HIV:

A. Strictly adhere to standard microbiologic practices and techniques

The most important recommendation is to adhere strictly to standard microbiologic practices and techniques. Persons working with HIV must be aware of potential hazards and must be trained and proficient in practice and techniques necessary for self-protection. Employees must be informed that parenteral exposure is the most serious potential hazard for causing a laboratory-acquired infection. They must be able to recognize how such

exposures occur and how they can be prevented. Although on-the-job training is an acceptable approach for learning techniques and practices, it is imperative that proficiency be obtained **BEFORE** virus is actually handled.

B. Assure that workers are proficient in virus-handling techniques

Selection criteria for employees who will work in production operations or with concentrated preparations of HIV should require experience in the handling of human pathogens or tissue cultures. If an employee has not had such experience, s/he should participate in carefully structured, well-supervised on-the-job training programs.

The director or person in charge of the laboratory or production facility must ensure that personnel are appropriately trained and are proficient in practices and techniques necessary for self-protection. Initial work activities should not include the handling of virus. A progression of work activities should be assigned as techniques are learned and proficiency is developed. Virus should only be introduced into the work activities after the supervisor is confident it can be handled safely.

C. Monitor work practices

Periodically, the biosafety officer or a person with expertise in biosafety should closely observe practices and techniques used in handling HIV. This can be helpful in identifying activities or behavior that may increase the potential for contact with contaminated material or for inapparent parenteral exposures. If deficiencies are noticed, corrective measures should be specified and implemented.

D. Continuously reinforce safe practices

Practices that reduce the potential for direct contact and inapparent parenteral exposure should be continuously reinforced:

- Gloves should always be worn when concentrated preparations of HIV are handled and when contact with a contaminated surface or material may be unavoidable. If a gloved hand accidentally touches a contaminated surface or material, the glove should be removed immediately and the hands washed.
- Work surfaces should be decontaminated at the end of each day and any time contamination is recognized.
- Workers must develop the habit of keeping hands away from the eyes, nose, and mouth in order to avoid potential exposure of mucous membranes. Wearing filter masks and eye goggles or face shields may assist in accomplishing this objective.
- Needles and sharp implements must not be used when HIV is handled unless no acceptable alternative is available. When possible, unbreakable containers should be substituted for glassware, in order to avoid accidental cuts from broken pieces.
- In the absence of advice and consent of an occupational physician or nurse, no worker should handle any virus-containing material when s/he has cuts or skin abrasions on the hands or wrists.

E. Establish a medical surveillance serology program

Each medical facility should have a medical-surveillance serology program. Serum samples should be obtained at least once a year and analyzed for

seroconversion. Results should be reported to individual workers in a timely manner. Counseling services should be available for workers who have positive serologic results. Procedures that maintain strict confidentiality should be adopted.

F. Revalidate integrity of process, transport, and containment equipment

The operational integrity of all equipment used to process, transport, and contain fluids containing HIV should be revalidated at least once a year. The integrity of such equipment should be revalidated after any system failure that releases contaminated fluids into the work environment.

G. Develop production processes that enhance biosafety

Efforts should be made to explore and use production systems and strategies that reduce operational complexity and manual manipulations.

H. Validate efficacy of decontamination methods

Special attention should be given to demonstrating the adequacy of decontamination methods when high organic content, such as cellular debris, is present.

I. Sponsor and conduct biosafety training initiatives

Responsible institutions should orient such programs toward the application of biosafety practices to work involving HIV. Presentation strategies and materials to make the training widely available should be encouraged.

References

1. CDC. Human T-lymphotropic virus type III/lymphadenopathy-associated virus: agent summary statement. MMWR 1986;35:540-2, 547-9.
2. Weiss SH, Goedert JJ, Gartner S, et al. Risk of human immunodeficiency virus (HIV-1) infection among laboratory workers. Science 1988;239:68-71.
3. CDC. Recommendations for prevention of HIV transmission in health-care settings. MMWR 1987;36(suppl 2S):3S-18S.

CENTERS FOR DISEASE CONTROL

MMWR

MORBIDITY AND MORTALITY WEEKLY REPORT

April 22, 1988 / Vol. 37 / No. 15

Epidemiologic Notes and Reports

Update: Acquired Immunodeficiency Syndrome and Human Immunodeficiency Virus Infection Among Health-Care Workers

Acquired immunodeficiency syndrome (AIDS) among health-care workers in the United States results primarily from human immunodeficiency virus (HIV) infections that occur outside of the health-care setting. However, a small number of health-care workers have been infected with HIV through occupational exposures, and one such worker has developed AIDS after documented seroconversion. This report summarizes and updates both national surveillance data for AIDS among health-care workers and data from prospective studies on the risk of HIV transmission in the health-care setting.

Health-Care Workers with AIDS

The AIDS case report form used by CDC requests that state and local health departments collect information on employment since 1978 in a health-care or clinical laboratory setting. For surveillance purposes, any person who indicates such employment is classified as a health-care worker.

As of March 14, 1988, a total of 55,315 adults with AIDS had been reported to CDC. Occupational information was available for 47,532 of these persons, 2,586 (5.4%) of whom were classified as health-care workers. A similar proportion (5.7%) of the U.S. labor force was employed in health services (*1*).

Forty-six states, the District of Columbia, and Puerto Rico have reported health-care workers with AIDS. Like other AIDS patients, health-care workers with AIDS had a median age of 35 years. Males accounted for 91.6% of health-care workers with AIDS and 92.4% of other patients with AIDS. The majority of health-care workers with AIDS (62.8%) and of other AIDS patients (60.5%) were white.

Ninety-five percent of the health-care workers with AIDS were classified into known transmission categories (Table 1). Health-care workers with AIDS were significantly less likely than others with AIDS to be intravenous drug abusers and more likely to be homosexual or bisexual men. They were also less likely to have a known risk factor reported ($p < 0.001$).

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES / PUBLIC HEALTH SERVICE

AIDS and HIV — Continued

To determine the possible cause of HIV infection, state and local health departments investigate those AIDS patients reported as having no identified risk. As of March 14, 1988, investigations had been completed for 121 of the 215 health-care workers initially reported with undetermined risk. Risk factors were identified for 80 (66.1%) of these. Of the 135 health-care workers who remain in the undetermined-risk category, 41 (30.4%) could not be reclassified after follow-up; 20 (14.8%) had either died or refused to be interviewed; and 74 (54.8%) are still under investigation.

Overall, 5.3% of health-care workers with AIDS had an undetermined risk. When examined by year of report to CDC, the proportion of such health-care workers appears to have increased from 1.5% in 1982 to 6.2% in 1987. However, 71 of the 135 health-care workers for whom risk is still undetermined have been reported since March 1987, and 80.0% of these 71 cases are still under investigation. The proportion of other AIDS patients with an undetermined risk has also increased over time. However, previous experience suggests that other risk factors for HIV infection will be identified for many of these persons when investigations have been completed (*2*). Ten percent of all reported AIDS patients with undetermined risk are health-care workers; this proportion has not changed over time.

A health-care worker reported to have developed AIDS after a well-documented occupational exposure to blood and HIV seroconversion is included among the 80 health-care workers who were reclassified after follow-up. The worker was accidentally self-injected with several milliliters of blood from a hospitalized patient with AIDS while filling a vacuum collection tube. Investigation revealed no other risk factors for this health-care worker.

Forty-one health-care workers could not be reclassified after investigation; 68.3% were men. In contrast, 23.0% of individuals employed in hospitals and health services in the United States are men (*1*). These 41 health-care workers comprised eight physicians, four of whom were surgeons; one dentist; five nurses; eleven nursing assistants or orderlies; seven housekeeping or maintenance workers; four clinical laboratory technicians; one respiratory therapist; one paramedic; one mortician; and two others who had no contact with patients or clinical specimens. A comparison of

TABLE 1. Comparison of health-care workers with AIDS and other AIDS patients reported to CDC, by transmission category — through March 14, 1988

Transmission Category	Health-Care Workers with AIDS		Other AIDS Patients	
	No.	(%)	No.	(%)
Homosexual or Bisexual Male	1,916	(74.1)*	28,820	(64.1)
Heterosexual Intravenous Drug Abuser	161	(6.2)*	8,263	(18.4)
Homosexual or Bisexual Male and Intravenous Drug Abuser	187	(7.2)	3,267	(7.3)
Hemophilia/Coagulation Disorder	20	(0.8)	451	(1.0)
Heterosexual	119	(4.6)	1,772	(3.9)
Blood/Blood Component Recipient	47	(1.8)	1,105	(2.5)
Other†	1	(<1.0)	0	(0.0)
Undetermined§	135	(5.3)*	1,268	(2.8)
Total	**2,586**	**(100.0)**	**44,946**	**(100.0)**

*$p<0.001$, chi square analysis.

†Represents health-care worker who seroconverted to HIV and developed AIDS after documented needlestick exposure to blood.

§Includes patients who are under investigation, who died or refused interview, or for whom no risk was identified after follow-up.

AIDS and HIV — Continued

the occupations of these 41 health-care workers with those of health-care workers for whom risk factors and job information were available showed that maintenance workers were the only occupational group significantly more likely to have an undetermined risk (7 [17.1%] of 41 health-care workers with undetermined risk, compared with 160 [7.1%] of 2,263 health-care workers with identified risk, p = 0.02).

Seventeen of the 41 investigated health-care workers with undetermined risk (including two of the seven maintenance workers) reported needlestick and/or mucous-membrane exposures to the blood or body fluids of patients during the 10 years preceding their diagnosis of AIDS. However, none of the patients was known to be infected with HIV at the time of exposure, and none of the health-care workers was evaluated at the time of exposure to document seroconversion to HIV antibody. None of the remaining 24 health-care workers reported needlestick or other nonparenteral exposures to blood or body fluids.

Other Health-Care and Laboratory Workers with HIV Infection

As of December 31, 1987, 1,176 health-care workers had been enrolled and tested for HIV antibody in ongoing CDC surveillance of health-care workers exposed to blood or other body fluids from HIV-infected patients. Of the 1,070 workers tested ≥90 days after exposure, 870 (81.3%) had parenteral exposures to blood; 104 (9.7%) had exposures of mucous membrane or nonintact skin to blood; and 96 (9.0%) had exposures to other body fluids (Table 2).

Four (0.5%) of the 870 workers with parenteral exposures to blood were seropositive for HIV antibody (upper bound of the 95% confidence interval [CI] = 1.1%). However, one of these four was not tested until 10 months after exposure (*3,4*). In addition, this worker had an HIV-seropositive sexual partner, and heterosexual acquisition of infection could not be excluded. Of the 489 health-care workers who sustained parenteral exposures to blood and for whom both acute- and convalescent-phase serum samples had been obtained, three, or 0.6%, seroconverted to HIV within 6 months of exposure (upper bound of the 95% CI = 1.6%) (*4-6*). Investigation revealed no nonoccupational risk factors for these three workers.

Two other ongoing prospective studies assess the risk of nosocomial acquisition of HIV infection among health-care workers in the United States (*7,8*). As of April 30, 1987, the National Institutes of Health had tested 103 health-care workers with documented needlestick injuries and 691 health-care workers with more than 2,000 cutaneous or mucous-membrane exposures to blood or other body fluids of

TABLE 2. HIV infection among health-care workers, by type of exposure and body fluid — CDC Prospective Study, August 15, 1983–December 31, 1987

Type of Exposure	No. of Health-Care Workers with Exposure to				No. of Infections
	Blood	Saliva	Urine	Other/Unknown	
Parenteral (needlestick or cut with sharp object)	870	7	3	21	4*
Contamination of mucous-membrane, open wound, or nonintact skin	104	42	12	11	0

*All four health-care workers had parenteral exposure to HIV-infected blood; risk is 4/870, or 0.5% (upper bound of 95% confidence interval = 1.1%).

AIDS and HIV – Continued

HIV-infected patients; none had seroconverted (*7*). As of March 15, 1988, a similar study at the University of California of 235 health-care workers with 644 documented needlestick injuries or mucous-membrane exposures had identified one seroconversion following a needlestick (*9*; University of California, San Francisco, unpublished data). Prospective studies in the United Kingdom and Canada show no evidence of HIV transmission among 220 health-care workers with parenteral, mucous-membrane, or cutaneous exposures (*10,11*).

In addition to the health-care workers enrolled in these longitudinal surveillance studies and the case reported here, six persons from the United States and four persons from other countries who denied other risk factors for HIV infection have reportedly seroconverted to HIV after parenteral, nonintact skin, or mucous-membrane exposures to HIV-infected blood or concentrated virus in a health-care or laboratory setting (Table 3) (*12-20*). Six additional health-care workers with no other identified risk factors reportedly acquired HIV infection, but the date of seroconversion is unknown (*3,15,21-23*).

Reported by: AIDS Program, Hospital Infections Program, Center for Infectious Diseases, CDC.

Editorial Note: These data are consistent with previous observations that the occupational risk of acquiring HIV in health-care settings is low and is most often associated with percutaneous inoculation of blood from a patient with HIV infection. Prospective surveillance studies, which provide data on the magnitude of the risk of HIV infection, indicate that the risk of seroconversion following needlestick exposures to blood from HIV-infected patients is less than 1.0%. The level of risk associated with the exposure of nonintact skin or mucous membranes is likely far less than that associated with needlestick exposures. Individual published case reports must be interpreted with caution because they provide no data on the frequency of occupational exposures to HIV or the proportion of exposures resulting in seroconversion.

The reasons that a higher proportion of health-care workers with AIDS have no identified risk than do other persons with AIDS are unknown. They could include a tendency of health-care workers not to report behavioral risk factors for HIV infection, the occupational risk of HIV infection as a result of blood exposure, or both. The first hypothesis is suggested by the overrepresentation of men among these health-care workers, a finding that is similar to the overrepresentation of men among AIDS patients infected with HIV through sexual activity or intravenous drug abuse. The second hypothesis is suggested by the documentation of HIV transmission in the health-care setting. Similar hypotheses may be raised for the apparent excess of maintenance personnel among health-care workers with no identified risk for AIDS. Occupationally acquired HIV infection in such workers would be difficult to determine unless the source patient or clinical specimen was known to be HIV-positive, the occupational exposure had been well documented, and the HIV seroconversion of the health-care worker had been detected.

The increasing number of persons being treated for HIV-associated illnesses makes it likely that more health-care workers will encounter patients infected with HIV. The risk of transmission of HIV can be minimized if health-care workers use care while performing all invasive procedures, adhere rigorously to previously published recommendations, and use universal precautions when caring for all patients (*5*). In addition, employers should instruct health-care workers on the need for routine use of universal precautions, provide equipment and clothing necessary to minimize the risk of infection, and monitor workers' adherence to these precautions (*5,24*).

AIDS and HIV – Continued

TABLE 3. HIV-infected health-care workers with no reported nonoccupational risk factors and for whom case histories have been published in the scientific literature

Cases with Documented Seroconversion					
Case	**Occupation**	**Country**	**Type of Exposure**	**Source**	**Reference**
1*	NS†	United States	Needlestick	AIDS patient	This report
2	NS	United States	Needlestick	AIDS patient	(*4,6*)
3	NS	United States	Needlestick	AIDS patient	(*5*)
4	NS	United States	2 Needlesticks	AIDS patient, HIV-infected patient	(*5*)
5	NS	United States	Needlestick	AIDS patient	(*9*)
6	Nurse	England	Needlestick	AIDS patient	(*12*)
7	Nurse	France	Needlestick	HIV-infected patient	(*13*)
8	Nurse	Martinique	Needlestick	AIDS patient	(*14*)
9	Research lab worker	United States	Cut with sharp object	Concentrated virus	(*15,16*)
10	Home health-care provider	United States	Cutaneous§	AIDS patient	(*17*)
11	NS	United States	Nonintact skin	AIDS patient	(*18*)
12	Phlebotomist	United States	Mucous-membrane	HIV-infected patient	(*18*)
13	Technologist	United States	Nonintact skin	HIV-infected patient	(*18*)
14	NS	United States	Needlestick	AIDS patient	(*19*)
15	Nurse	Italy	Mucous-membrane	HIV-infected patient	(*20*)
Cases without Documented Seroconversion					
Case	**Occupation**	**Country**	**Type of Exposure**	**Source**	**Reference**
1	NS	United States	Puncture wound	AIDS patient	(*3,4*)
2	NS	United States	2 Needlesticks	2 AIDS patients	(*3*)
3	Research lab worker	United States	Nonintact skin	Concentrated virus	(*15,16*)
4	Home health-care provider	England	Nonintact skin	AIDS patient	(*21*)
5	Dentist	United States	Multiple needlesticks	Unknown	(*22*)
6*	Technician	Mexico	Multiple needle-sticks and mucous-membrane	Unknown	(*23*)
7	Lab worker	United States	Needlestick, puncture wound	Unknown	(*3*)

*Health-care worker diagnosed with AIDS.
†NS = not specified.
§Mother who provided nursing care for her child with HIV infection; extensive contact with the child's blood and body secretions and excretions occurred; the mother did not wear gloves and often did not wash her hands immediately after exposure.

References

1. Bureau of Labor Statistics. Employment and earnings. Washington, DC: US Department of Labor, Bureau of Labor Statistics, 1988;35:13,93,194.
2. Castro KG, Lifson AR, White CR, et al. Investigations of AIDS patients with no previously identified risk factors. JAMA 1988;259:1338-42.

AIDS and HIV — Continued

3. 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.
4. McCray E, The Cooperative Needlestick Surveillance Group. Occupational risk of the acquired immunodeficiency syndrome among health care workers. N Engl J Med 1986; 314:1127-32.
5. Centers for Disease Control. Recommendations for prevention of HIV transmission in health-care settings. MMWR 1987;36(suppl 2S).
6. Stricof RL, Morse DL. HTLV-III/LAV seroconversion following a deep intramuscular needle-stick injury [Letter]. N Engl J Med 1986;314:1115.
7. Henderson DK, Saah AJ, Fahey BJ, Schmitt JM, Lane HC. Prospective assessment of the risk for occupational/nosocomial infection with human immunodeficiency virus in a large cohort of health care workers [Abstract no. 76]. In: Program and abstracts of the Twenty-Seventh Interscience Conference on Antimicrobial Agents and Chemotherapy. Washington, DC: American Society for Microbiology, 1987:109.
8. 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.
9. Gerberding JL, Henderson DK. Design of rational infection control policies for human immunodeficiency virus infection. J Infect Dis 1987;156:861-4.

(Continued on page 239)

AIDS and HIV — Continued

10. 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.
11. Health and Welfare Canada. National surveillance program on occupational exposure to HIV among health-care workers in Canada. Canada Dis Weekly Rep 1987;13-37:163-6.
12. Anonymous. Needlestick transmission of HTLV-III from a patient infected in Africa. Lancet 1984;2:1376-7.
13. Oksenhendler E, Harzic M, Le Roux JM, Rabian C, Clauvel JP. HIV infection with seroconversion after a superficial needlestick injury to the finger [Letter]. N Engl J Med 1986; 315:582.
14. Neisson-Vernant C, Arfi S, Mathez D, Leibowitch J, Monplaisir N. Needlestick HIV seroconversion in a nurse [Letter]. Lancet 1986;2:814.
15. Weiss SH, Goedert JJ, Gartner S, et al. Risk of human immunodeficiency virus (HIV-1) infection among laboratory workers. Science 1988;239:68-71.
16. Centers for Disease Control. 1988 agent summary statement for human immunodeficiency virus and report on laboratory-acquired infection with human immunodeficiency virus. MMWR 1988;37(suppl S-4).
17. Centers for Disease Control. Apparent transmission of human T-lymphotrophic virus type III/lymphadenopathy-associated virus from a child to a mother providing health care. MMWR 1986;35:76-9.
18. Centers for Disease Control. Update: human immunodeficiency virus infections in health-care workers exposed to blood of infected patients. MMWR 1987;36:285-9.
19. Ramsey KM, Smith EN, Reinarz JA. Prospective evaluation of 44 health care workers exposed to human immunodeficiency virus-1, with one seroconversion [Abstract]. Clin Res 1988;36:1A.
20. 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.
21. Grint P, McEvoy M. Two associated cases of the acquired immune deficiency syndrome (AIDS). PHLS Commun Dis Rep 1985;42:4.
22. Klein RS, Phelan JA, Freeman K, et al. Low occupational risk of human immunodeficiency virus infection among dental professionals. N Engl J Med 1988;318:86-90.
23. Ponce de León RS, Sánchez-Mejorada G, Zaidi-Jacobson M. AIDS in a blood bank technician in Mexico City [Letter]. Infect Control Hosp Epidemiol 1988;9:101-2.
24. US Department of Labor, US Department of Health and Human Services. Joint Advisory Notice: protection against occupational exposure to hepatitis B virus (HBV) and human immunodeficiency virus (HIV). Federal Register 1987;52:41818-24.