Acquired Immunodeficiency Syndrome: Current and Future Trends

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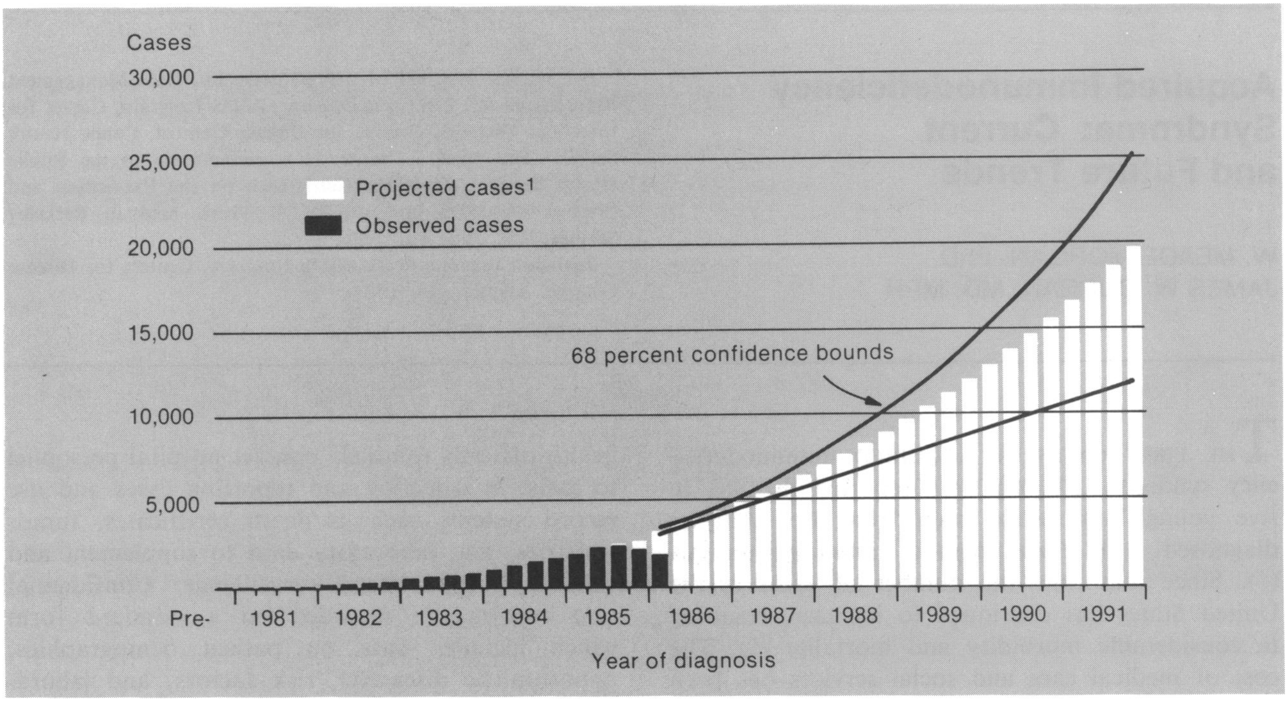
THE FIRST CASES OF ACQUIRED immunodeficiency syndrome (AIDS) were reported in 1981 in five young homosexual men from Los Angeles diagnosed with *Pneumocystis carinii* pneumonia (*1*). Since that time the number of cases in the United States has continued to increase, resulting in considerable morbidity and mortality (*2*). The cost of medical care and social services has been high, and medical practitioners and public health officials have expressed concerns about the adequacy and availability of personnel and facilities to meet future needs. Planning for the future requires accurate projections of the number of persons with AIDS and other medical and social problems related to human T-cell lymphotropic virus/lymphadenopathy-associated virus (HTLV-III/LAV) infection. (The designation human immunodeficiency virus (HIV) has recently been proposed by a subcommittee of the International Committee for the Taxonomy of Viruses as the appropriate name for the retrovirus that has been implicated as the causative agent of AIDS (*3*).) As a basis for planning, trends among AIDS cases reported to the Centers for Disease Control (CDC) were analyzed, and empirical models were employed to project the number and the distribution of AIDS cases through 1991. In this paper we provide a detailed description of the demographic projections that serve as the basis for the "Public Health Service Plan for the Prevention and Control of AIDS and the AIDS Virus" (*4*).

Trends in the numbers of AIDS cases in the United States meeting the surveillance definition and reported to the CDC were analyzed for the period beginning June 1981 through May 16, 1986. Surveillance for AIDS is conducted by health departments in every State, district, and U.S. territory. In most areas, surveillance activities are both passive and active. In many areas, public health officials routinely contact hospital personnel to assist in detecting and reporting cases and use record systems such as death certificates, tumor registries, and laboratory data to supplement and validate hospital-based surveillance. Confidential case reports are recorded on a standard form which includes data on patient demographics, opportunistic disease(s), risk factors, and laboratory tests. Information from the forms without personal identifiers is coded and computerized either at CDC or at health departments where it is then transmitted electronically to CDC.

The models used to project the number and the distribution of AIDS cases by patient group, geographic area of residence, gender, race, and age are empirical in the sense that they reflect observed trends in the distribution of reported cases and assume that these trends will continue unchanged over time (*5*). The projections involve a two-stage process. First, the cases reported each month are adjusted to obtain estimates of the cases actually diagnosed during that month. Second, a quadratic polynomial is fitted using weighted linear regression to the adjusted case counts as transformed by a modified Box-Cox method (*6*), and the resulting model is projected to 1991. The transformation was used to obtain homoscedastic weighted residuals suitable for calculating confidence intervals. The 68 percent (one standard deviation) confidence bounds account for the usual residual variance in the model as well as the statistical error introduced by adjusting the case counts and applying the Box-Cox transformation. The bounds are valid under the assumption that the quadratic polynomial model, as fit under the Box-Cox transformation, will hold throughout the entire period.

To obtain estimates for the number of AIDS-associated deaths, survival times were calculated from surveillance data using the Kaplan-Meier

Incidence of AIDS in the United States, by quarter of diagnosis—projected from cases reported as of April 30, 1986



[1]Adjusted for reporting delays.

method for life table analysis (*7*). The estimated median survival time was 12 months and the cumulative 3-year survival was estimated to be 28 percent. Because of a lack of followup information related to patients' deaths, surveillance data will considerably overestimate true survival rates after the first year. To project AIDS-related mortality reasonably through the third year after diagnosis and beyond, it was assumed that the cumulative survival times follow a negative exponential distribution with 50 percent of patients living at most 1 year and only 12 percent surviving for more than 3 years (*8*). The distribution was applied to the upper and lower bounds for projections on the incidence of AIDS to obtain a range for the number of AIDS-related deaths through 1991.

Changes in the distribution of diagnosed cases over time were tested using the chi-square test for linear trends when testing proportions or the Spearman rank correlation when testing continuous variables. To project future trends in the distribution of cases, weighted linear regression on the logits of proportions was used. For each month from January 1983 until April 1986, the logit of the proportion of AIDS cases in each category was calculated ($\text{logit}(p) = \log(p) - \log(1-p)$). Weights were taken to be proportional to the inverse of the approximate variance of $\text{logit}(p)$, that is $np(1-p)$ where n is the number of AIDS patients diagnosed in the given month and p is the proportion of patients in the particular category. The changes in the logit proportions were assumed to be linear over time. Quadratic effects were rarely statistically significant and were not considered further. Only cases diagnosed after 1982 were used in order to allow times of diagnosis and reporting to have stabilized. The parameter estimates were restricted so that the projected proportions of cases in both 1986 and 1991 would sum to 100 percent. For the 1991 estimates, 68 percent confidence bounds on the resulting proportions were calculated.

Results

Between June 1, 1981, and May 19, 1986, physicians and health departments in the United States reported 20,766 cases of AIDS. Of these, 20,473 (98.6 percent) were diagnosed in adults and 293 (1.4 percent) in children. The number of cases has increased steadily, but the doubling times continue to lengthen, indicating that the rate of increase is not exponential. For example, between July 1981 and February 1982 approximately 1,000 cases of AIDS had been diagnosed and reported. This number increased to 2,000 by July 1983, a

Table 1. Incidence of AIDS and associated mortality, United States, May 19, 1986

Year	Number of cases diagnosed during year	Projected cases: Lower bounds	Projected cases: Upper (68 percent) bounds	Number of deaths during year	Projected deaths: Lower range	Projected deaths: Upper range
1981 and before	321	...	...	146	...	...
1982	1,002	...	...	382	...	...
1983	2,736	...	...	1,225	...	...
1984	5,456	...	...	2,829	...	...
1985[1]	8,775	...	...	5,178	...	...
Projected						
1986	15,800	14,800	16,400	9,000	8,700	9,200
1987	23,000	21,000	25,000	14,000	13,000	15,000
1988	33,000	27,000	36,000	21,000	18,000	23,000
1989	45,000	33,000	51,000	30,000	24,000	33,000
1990	58,000	40,000	69,000	41,000	31,000	47,000
1991	74,000	46,000	92,000	54,000	37,000	64,000

[1]The numbers of diagnoses and deaths for 1985 are underestimated since reporting for this year is not yet complete.

6-month doubling time. More recently the number of cases has increased from 10,000 in May 1985 to 20,000 by April 1986, a doubling time of 11 months.

The chart depicts the projected incidence of AIDS through 1991. The adjustment for reporting delays indicates that 25,000 cases will be reported that have already been diagnosed through April 1986, although only 20,076 cases had been reported as of that time. It is projected that 15,800 new AIDS cases will be diagnosed in 1986, increasing to 74,000 cases in 1991 (table 1). The current number of cases is projected to double in 13 to 15 months, while the cumulative case total of 270,000 by the end of 1991 will represent a doubling over a 2-year period from the end of 1989.

The relative distribution of reported adult and pediatric cases has not changed significantly over time ($P > .15$). It is projected that 1.4 percent of 1986 cases (200) will occur in children under 13 years of age, decreasing slightly to 1.2 percent (1,000) of cases in 1991.

Trends by patient group. Ninety-four percent (18,879) of the total reported adult cases can be placed in patient groups that suggest a possible means of disease acquisition: homosexual or bisexual men with a history of intravenous (IV) drug abuse (8 percent); homosexual or bisexual men who are not known IV drug abusers (65 percent); heterosexual IV drug abusers (17 percent); persons with hemophilia (1 percent); heterosexual sex partners of persons with AIDS, HTLV-III/LAV infection, or persons who are at increased risk for AIDS (1 percent); and recipients of transfused blood or blood components (2 percent). Patients with multiple risk factors are included in the group listed first. The remaining 6 percent of adult cases have not been classified by recognized risk factors although 40 percent of these cases occurred in persons born in Haiti or in central African countries where heterosexual transmission is thought to account for a major share of the cases (*9, 10*).

The relative proportion of reported cases among the patient groups with the largest numbers of cases has remained stable over time since 1982 (table 2), while slight but statistically significant changes have occurred in the smaller patient groups. The most significant change is a decline in the proportion of AIDS patients born outside the United States, in Haiti or central African countries ($P < .0001$). The number of reported cases among persons born outside the United States has doubled in the past 18 months, compared with a doubling in 11 months for all other AIDS cases in adults. If current trends continue, this group will account for 1.3 percent of cases diagnosed in 1986 and only 0.3 percent of those diagnosed in 1991. The initially higher proportion of AIDS cases among Haitians may have been due to the migration to the United States during the period 1978 to 1981 of persons who were already infected (*10, 11*). Two other shifts in the distribution of cases are statistically significant. First, the proportion of diagnosed cases associated with blood transfusions and in hemophilia patients has increased slightly ($P = 0.01$) even though the proportion remains small (2.4 percent of the total adult cases). No cases of AIDS have been reported in persons who only received transfusions after routine HTLV-III/LAV

Table 2. Adult cases of AIDS with projections for 1991, by patient group, United States, May 19, 1986

Patient group	Reported cases, by year of diagnosis								Projected cases					
	1983 and before		1984		1985		1986		1986		1991			
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Percent	Number	Percent	Lower, (68 percent) bounds	Upper	Number
Homosexual, bisexual men[1]	2,868	72.3	4,000	74.3	6,373	73.4	1,757	71.9	72.6	11,300	70.0	(67.3,	72.6)	51,100
Heterosexual IV drug users	687	17.3	907	16.8	1,479	17.0	451	18.5	17.3	2,700	16.4	(14.5,	18.5)	12,000
Hemophilia patients	19	0.5	43	0.8	86	1.0	12	0.5	1.0	200	1.4	(1.0,	2.0)	1,000
Transfusion recipients	45	1.1	77	1.4	164	1.9	46	1.9	2.0	300	2.5	(1.8,	3.5)	1,800
Other heterosexual cases:														
Heterosexual contacts	36	0.9	65	1.2	151	1.7	52	2.1	2.0	300	5.0	(3.6,	6.8)	3,700
Born outside United States[2]	174	4.4	126	2.3	128	1.5	35	1.4	1.3	200	0.3	(0.2,	0.4)	200
Other, none of the above	138	3.5	165	3.1	297	3.4	92	3.8	3.7	600	4.5	(3.5,	5.8)	3,200
Total	3,967	100.0	5,383	100.0	8,678	100.0	2,445	100.0	100.0	15,600	100.0	...	...	73,000

[1] 12 percent of homosexual, bisexual men are also reported to have a history of IV drug use.

[2] Includes persons born in countries in which most AIDS cases have not been associated with known risk factors but where heterosexual transmission is believed to play a major role.

antibody testing of donors began in the spring of 1985, although one case of a seronegative donor transmitting infection has been reported (*12*). These continuing increases represent cases among persons infected prior to April 1985 as well as increased recognition of the disease among transfusion recipients, particularly elderly patients. The empirical model projects that 2.0 percent of adult AIDs cases in 1986 will be in persons whose only risk factor is the receipt of transfused blood or blood components and that this will increase to 2.5 percent in 1991.

The proportion of cases in the heterosexual contact risk group also has increased from 1983 to 1986 ($P < .0001$) although the total number of cases identified in this group is small (1.5 percent). If current trends continue, the proportion of heterosexual contact cases is projected to be 2.0 percent in 1986, increasing substantially to 5.0 percent in 1991. In addition to those cases reported as a result of heterosexual contacts, it is likely that a major portion of the cases without identified risk factors result from heterosexual transmission of the AIDS virus. An estimated 7 percent of cases diagnosed in 1986 will be among heterosexual contacts, persons born outside of the United States, and persons with no identified risk factor; the majority of cases in these three groups are thought to result from heterosexual transmission. The proportion in these groups is projected to increase to nearly 10 percent in 1991.

Trends by geographic area. The geographic distribution of diagnosed adult AIDS cases has changed markedly from 1983 to 1986 (table 3). The proportion of cases outside New York City and San Francisco has increased significantly ($P < .0001$). This proportionate change is most notable in relation to New York City and is primarily due to an increasing proportion of U.S. cases among homosexual men from other areas. The proportion of homosexual cases from outside of New York City and San Francisco has increased from 50 percent of cases diagnosed before 1984 to 65 percent of those diagnosed after 1984. The geographic distribution of cases among heterosexual IV drug users has changed less, with 44 percent of cases diagnosed before 1984 from outside of New York City compared with 47 percent of those diagnosed after 1984. The number of reported AIDS cases doubled in the past 14 months in New York City, in 13 months in San Francisco and in 10 months in the remainder of the United States. By 1991, only 12 percent of cases are projected to be diagnosed in the New York City and 8 percent in the San Francisco SMSAs, with 80 percent of the cases outside of these areas which had reported more than half of the cases from 1981 to 1983.

Table 3. Adult cases of AIDS with projections for 1991, by geographic area, United States, May 19, 1986

	Reported cases, by year of diagnosis								*Projected cases*					
	1983 and before		*1984*		*1985*		*1986*		*1986*		*1991*			
Geographic area	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Percent*	*Number*	*Percent*	*Lower, (68 percent)*	*Upper bounds*	*Number*
New York City SMSA..........	1,527	38.5	1,662	30.9	2,354	27.1	754	30.8	24.9	3,900	11.9	(10.8,	13.1)	8,700
San Francisco SMSA..........	442	11.1	591	11.0	866	10.0	284	11.6	10.1	1,600	8.1	(7.1,	9.3)	5,900
Florida	286	7.2	368	6.8	572	6.6	122	5.0	5.7	900	3.2	(2.7,	3.7)	2,300
Remainder, United States..........	1,712	43.2	2,762	51.3	4,886	56.3	1,285	52.6	59.2	9,200	76.9	(75.0,	78.8)	56,100
Total.......	3,967	100.0	5,383	100.0	8,678	100.0	2,445	100.0	100.0	15,600	100.0	...	...	73,000

NOTE: SMSA—Standard Metropolitan Statistical Area.

Table 4. Adult cases of AIDS with projections for 1991, by race, United States, May 19, 1986

	Reported cases, by year of diagnosis								*Projected cases*					
	1983 and before		*1984*		*1985*		*1986*		*1986*		*1991*			
Race	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Percent*	*Number*	*Percent*	*Lower, (68 percent)*	*Upper bounds*	*Number*
White	2,294	57.8	3,270	60.7	5,256	60.6	1,452	59.4	61.0	9,500	64.2	(62.2,	66.2)	46,900
Black	1,036	26.1	1,307	24.3	2,114	24.4	603	24.6	23.8	3,700	20.8	(19.3,	22.5)	15,200
Hispanic..........	568	14.3	747	13.9	1,227	14.1	370	15.1	14.5	2,300	14.8	(13.3,	16.4)	10,800
Other, unknown...	69	1.7	59	1.1	81	0.9	20	0.8	0.8	100	0.2	(0.1,	0.3)	100
Total.......	3,967	100.0	5,383	100.0	8,678	100.0	2,445	100.0	100.0	15,600	100.0	...	...	73,000

Trends by race, gender, and age. The distribution of cases by race in adults did not change significantly from 1983 to 1986 (table 4), and there has been a marginally significant increase in the proportion of persons with AIDS who are women ($P = .09$, table 5). There has also been a small but significant increase in the age of patients ($P = .02$). The mean age among patients diagnosed before 1984 is 36.3 years compared with 37.8 years for those diagnosed after 1984. Ninety-three percent of the reported cases are in men; 60 percent are white, 25 percent are black, 14 percent Hispanic; less than 1 percent of adult cases are in persons between 13 and 19 years of age, 21 percent between 20 and 29 years of age, 48 percent between 30 and 39, 21 percent between 40 and 49, and 9 percent are over 49. The increase in age has occurred primarily among heterosexual IV drug users whose mean age has increased from 34.2 years for those diagnosed before 1984 and 35.1 for those diagnosed after, and among blood transfusion recipients whose mean ages increased from 50.0 to 55.2 years respectively. The increase in age among adults is not significant if either heterosexual IV drug users or transfusion recipients are excluded ($P > .15$).

Trends among pediatric cases. Fifty-four percent or 159 pediatric cases have been in children born to a parent with a history of IV drug abuse, an additional 10 percent (28) are among children of parents with AIDS or are at other risk for AIDs, and 13 percent (39) are in children born to Haitian parents. Fifteen percent (44) of pediatric AIDs cases are in children who have received blood transfusions, and 4 percent (12) have hemophilia. Risk factor information is incomplete or missing for the remaining 4 percent (11 cases).

The distribution of pediatric cases by the patient's age, race, and geographic region has not changed significantly from 1983 to 1986. However, the number of cases is relatively small so that there is less ability to detect trends. Forty-nine percent of the cases were diagnosed in children under 1 year of age; 60 percent of the children are black and 21 percent are Hispanic; 38 percent have been reported from New York City, 14 percent from New Jersey and 14 percent from Florida. The

Table 5. Adult cases of AIDS with projections for 1991, by gender, United States, May 19, 1986

	Reported cases, by year of diagnosis								Projected cases					
	1983 and before		1984		1985		1986		1986		1991			
Gender	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Percent	Number	Percent	Lower, (68 percent)	Upper bounds	Number
Male	3,707	93.4	5,045	93.7	8,097	93.3	2,254	92.2	92.3	14,400	90.2	(88.4,	91.7)	65,800
Female	260	6.6	338	6.3	581	6.7	191	7.8	7.7	1,200	9.8	(8.3,	11.6)	7,200
Total	3,967	100.0	5,383	100.0	8,678	100.0	2,445	100.0	100.0	15,600	100.0	...	...	73,000

distribution of pediatric cases by geographic area is similar to that of cases in women who use IV drugs or are born outside of the United States.

Discussion

AIDS will become an even more serious public health problem in the United States during the next 5 years with a concurrent need for medical and social services for AIDS patients. The empirical model projects that 74,000 patients will be diagnosed in 1991 alone. An estimated 70,000 patients diagnosed during previous years will also require care during 1991.

These projections are conservative since they are based only upon cases reported to CDC. A review of death certificates over a 3-month period in four different metropolitan areas in the United States suggested that an additional 10 percent of diagnosed cases of AIDS are not reported to the CDC (*13*). At least an additional 10 percent of patients may be seriously ill with other Group IV HTLV-III/LAV infections (*14*) which do not fit current surveillance criteria (such as severe constitutional disease of "wasting syndrome" without a specific opportunistic infection or tumor). Thus the figures we present may underestimate by 20 percent or more the future morbidity and mortality due to HTLV-III/LAV infection.

Because of the lengthy period between infection with HTLV-III/LAV and the diagnosis of AIDS, most of the cases projected to occur in the next 5 years will be among persons already infected. Thus the majority of cases in 1991 will be in homosexual and bisexual men. Cases in "other heterosexual men and women" are projected to increase to more than 7,000 (nearly 10 percent). Most of these will occur among those already infected. Future trends in the geographic distribution of cases also reflect the current distribution of AIDS virus infection.

The empirical models do not consider the availability of therapy, vaccine, preventable cofactors, or the effectiveness of primary prevention efforts. If effective therapeutic regimens soon become widely available, the course of disease could be altered for those already infected. However, effective primary prevention of future HTLV-III/LAV infections through vaccines, counseling and testing, and education will have little impact on the number of cases occurring before 1990 due to the long incubation period and the large number of persons already infected. In some areas, prevention efforts have already been successfully implemented so that the empirical model may overestimate future cases, that is, among persons with hemophilia and recipients of transfusions.

Epidemiologic models for projecting the future incidence of AIDs will require additional information on the incidence, prevalence, and natural history of HTLV-III/LAV infection and on the effectiveness of efforts to prevent virus transmission. Our current understanding of the severity of AIDs and projections for the future underscore the need for continued commitment to research for a vaccine and therapy. Primary prevention and education activities must be widely implemented now throughout the United States to curtail the further spread of infection and future AIDS cases.

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10 Years After NHANES I: Report of Initial Followup, 1982–84

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Synopsis

The NHANES I Epidemiologic Followup Study (NHEFS) was jointly initiated by the National Center for Health Statistics and the National Institute on Aging in collaboration with other National Institutes of Health and Public Health Service agencies. The goal of NHEFS is to examine the relationship of baseline clinical, nutritional, and behavioral factors assessed in the first National Health and Nutrition Examination Survey (NHANES I—1971-75) to subsequent morbidity and mortality. Data collection for the initial phase of followup took place between 1982 and 1984 and included tracing of all NHANES I participants, determining their vital status, conducting in-depth interviews with surviving participants or with proxies for those who were deceased or incapacitated, conducting selected physical measurements, obtaining facility records for stays in hospitals or nursing homes that occurred during the period of followup, and obtaining death certificates for decedents.

Ninety-three percent of the original cohort was successfully traced. Interviews were conducted for 93 percent of traced, surviving participants and 84 percent of traced, deceased subjects. Physical measurements were obtained for approximately 95 percent of surviving, interviewed subjects. Death certificates are available for more than 95 percent of the decedents, and 18,136 facility records were received for 6,477 subjects.