

TechnologyReview



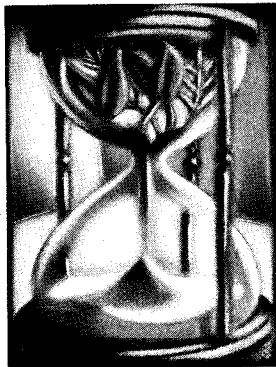
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Design by Nancy Cahners



y 1991,

*2.5 million Americans will
be infected with the AIDS virus.*

*The disease is devastating certain
communities, but it is not
spreading among heterosexuals as
rapidly as reports have
suggested.*

The AIDS Epidemic: Looking into the 1990s

BY JEFFREY E. HARRIS

By April 1987, the U.S. Centers for Disease Control (CDC) had reported nearly 34,000 cases of acquired immune deficiency syndrome (AIDS)—a disease unknown before 1981. How many more cases should we expect in this country? Tens of thousands? Hundreds of thousands? Millions? Will AIDS spread through the heterosexual community as it already has among homosexual men and intravenous drug users?

We cannot predict when there will be effective drugs or vaccines. Nor can we forecast trends in sexual practices or intravenous drug use. Still, we now have enough information to make an intelligent prediction about the course of the AIDS epidemic over the next three to four years. My task in this article is to assemble the available facts and offer such a prediction.

According to my research, the virus that causes AIDS has already infected about 900,000 individuals in this country. Barring major changes in sexual behavior and intravenous drug use, we can reasonably expect about 2.5 million people in the United States to be infected by early 1991. The infections will continue to arise from sexual intercourse and transfers of blood via contaminated needles—not from other personal contacts in the home, school, or workplace.

Unless we suddenly find a drug that halts the progression from initial infection to full-blown AIDS, I estimate that the toll of the epidemic will reach about 250,000 cases by early 1991. Since the disease has a long incubation period, most of the people who will contract the disease by that time are infected now.

Among the nearly 34,000 cases of AIDS reported by April 1987, about 2 percent are people who have

been exposed to the virus exclusively through heterosexual contact in this country. Among the 900,000 who are infected but well, about 3 to 4 percent have been exposed by the heterosexual route. The vast majority of currently infected heterosexuals have received the virus from bisexual men and intravenous drug users. At least at present, transmission of the virus between two exclusively heterosexual partners who are not intravenous drug users is a rare event.

In the next three or four years, the main source of infections in the heterosexual community will continue to be sexual contacts with bisexual men and intravenous drug users. As we move further into the 1990s, however, enough heterosexuals may become infected to make the spread from one heterosexual to another significant.

Even if the heterosexual phase of the epidemic fails to reach this level, the total number of AIDS cases will be large enough to place a severe burden on our health-care and insurance systems as well as our society at large. By 1991, AIDS patients could occupy one in ten hospital beds in New York, San Francisco, and other urban centers. And as insurance companies and employers feel the pressure to exclude people at risk for AIDS, the government will have to step in with public funding of all AIDS care.

Delays in Reporting: A Serious Problem

By the time a case of AIDS is reported to the CDC in Atlanta, three important steps have taken place. First, the stricken individual has been infected with the virus. Second, after an incubation period, the individual has developed AIDS, which then has been diagnosed by a physician. Third, the physician or

hospital has reported the case to the local or state health department, which in turn has transmitted the information to the CDC. We need to analyze each of these steps in detail. Just to extrapolate from statistics on reported cases—the numbers at the end of the line—would not be terribly helpful.

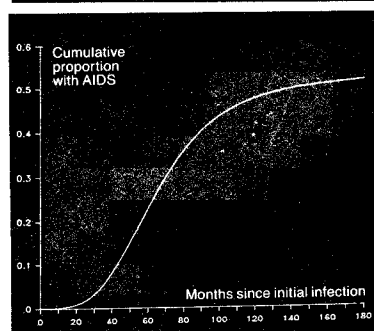
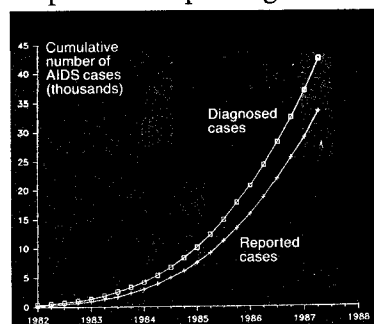
Researchers have carefully studied whether the CDC's reporting system misses a significant number of AIDS cases. But the more serious problem is the long time it takes to report AIDS cases. The reporting system is essentially passive; health departments wait to hear from doctors and hospitals. Only about 5 percent of AIDS cases are reported in the same month as they are diagnosed. About 11 percent take over a year to come in. Of the 337 cases that were diagnosed in 1981, 15 were not reported until 1986 or later.

Fortunately, the records of reported cases include their date of diagnosis. From such information, one can estimate the trend in diagnosed cases. By the end of March 1987, a total of 33,550 cases had been reported to the CDC, yet I estimate that an additional 9,000 had been diagnosed. While the CDC was receiving reports on about 4,500 new cases per quarter-year, the actual incidence was closer to 5,600. So from now on, I will be working with estimates of actual AIDS incidence, rather than with rates of reporting.

The CDC may soon expand its reporting of AIDS

Official documentation of AIDS cases lags far behind the actual spread of the disease. By March 31 of this year, the Centers for Disease Control had 33,550 cases on record, but an additional 9,000 had not yet been reported (top graph).

The author estimates that only about 53 percent of the people infected with the human immunodeficiency virus (HIV) will develop AIDS (bottom graph). The median incubation period is about five and a half years.



to include both the dementia the virus can cause and the "wasting syndrome"—in which patients become so emaciated that they look as if they are wasting away. In this article, however, I will use the current CDC definition, which includes unusual infections and cancers arising from a breakdown in the afflicted person's immune system.

A Long Incubation Period

AIDS does not necessarily occur in everyone who is infected by the human immunodeficiency virus (HIV). Nor do people develop the disease immediately after infection. The incubation period is long and variable. A few of the early studies suggested that a significant fraction of infected persons could develop AIDS within one or two years. But these studies had measured the incubation period from the time the infected subject entered the study, not from the time of initial infection.

Three more recent studies have measured the incubation period accurately, pinpointing the date of initial infection. In one study, CDC scientists analyzed 83 AIDS patients who had been originally infected by transfusion with contaminated blood. Although the number of subjects was small, the researchers were able to draw a curve showing the range of incubation times. According to this curve, the median incubation period among people who do develop AIDS is between four and a half and six and a half years. Since the researchers studied only people who developed AIDS, their curve was not "scaled." They could not determine what fraction of infected individuals will contract the disease.

In a second study, researchers identified the date of initial infection among 51 hemophiliacs in Hershey, Pa. These patients had received the virus through contaminated samples of Factor VIII, the blood component used to treat hemophilia. After two and a half years, 2 percent had developed AIDS, and after four years, an estimated 10 percent had contracted the disease.

In a third unpublished study, CDC scientists identified a cohort of San Francisco homosexuals whose blood samples had originally been collected in 1977–78 for a study of hepatitis B. Some of these men consented to have their samples re-analyzed for antibodies to HIV. By following the sequence of blood samples collected from each man, the investigators could determine when a previously uninfected sub-



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ject had first raised antibodies to HIV. Again the number of subjects was less than 100, but the results so far have shown that 4 percent of the infected subjects developed AIDS after three years, 14 percent after five years, and 36 percent after seven years.

AIDS might be “turned on” in an infected person by a second viral infection or some other insult to the body’s immune system. Conceivably, the three different groups studied—transfusion recipients, hemophiliacs, and homosexual men—could vary in their susceptibility to such triggering insults and thus have different incubation periods. Yet the data from the three studies are quite consistent. Relatively few subjects developed AIDS in the first three years after infection, though they may have had swollen glands, fever, and other symptoms. After seven years, many infected persons still had not developed the disease, though a fraction may have been ill with “AIDS-related complex” (ARC), a less lethal illness caused by the virus.

By combining the results of the three studies, I have produced a composite curve of the total percentage of infected persons who will develop AIDS over a given time period. I started with the unscaled curve that was identified in the study of transfusion recipients. When I scaled this curve to the point where it indicated that 53 percent of infected persons would come down with AIDS after fifteen years, I saw that it also fit the four-year follow-up data on hemophiliacs and the seven-year data on homosexual men. From the composite curve, I estimate that

AIDS will develop in 4 percent of all infected people after three years and 40 percent after seven and a half years. The median incubation period is five and a half years.

How Many Are Infected and Who Are They?

Now that we have characterized the incubation period, we can work backward from the data on AIDS cases to determine the number of individuals infected by HIV. In doing so, we learn that the virus actually began infecting the American population in about 1977. Five years later, AIDS was recognized as a major epidemic, yet the virus, still to be discovered, had already infected an estimated 70,000 individuals. By early 1985, when an antibody test for the newly discovered virus came into use, an estimated 400,000 were infected. My computations indicate that by mid-1987, 900,000 will have been infected.

This figure is pretty much in accord with other computations on the prevalence of HIV infection. In 1948 Alfred Kinsey estimated that about 4 percent of adult men had had regular homosexual contacts, while a larger proportion had had at least one sexual experience leading to orgasm with another man. If we suppose that 7 to 8 percent of all men aged 16 to 55 have been homosexually or bisexually active during the past 10 years, we arrive at a total of 5 million nationwide. While the rate of HIV infection in bisexual and homosexual men ranges from 20 to 70 percent in the cities where AIDS started, the nationwide proportion is more likely to be around 15 percent. From these estimates, we can deduce that there are 750,000 currently infected homosexual and bisexual men.

In addition, social scientists have calculated that there are 500,000 heroin addicts in the United States.

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*or the short term at least,
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intravenous drug user.*

While estimates of how many addicts are infected vary, the nationwide proportion appears to be around 20 percent. That yields an additional 100,000 individuals with the virus.

Hence, there are 850,000 infected persons among the two groups first hit by the AIDS virus. Among the groups second hit, there are about 10,000 hemophiliacs, 1,000 to 2,000 children conceived by infected mothers, and (as explained later) about 30,000 adults infected by exclusively heterosexual contact with first-hit persons. Adding up all these cases, we come fairly close to the 900,000 figure.

Once we have traced the path of HIV infection to date, we can work forward to determine the incidence of AIDS in the future. Because the model of HIV spread becomes increasingly uncertain during 1986-87, we cannot forecast AIDS incidence with any precision beyond 1990 or 1991. Predictions beyond three or four years would also require clairvoyance about the advent of drugs and vaccines.

The pace of viral spread outward from San Francisco, Los Angeles, Miami, Newark, and New York may be slower than it was within these cities. Even in the areas initially hit by the epidemic, the rate of new infection appears to be slowing. Part of the reason is that the virus has reached homosexuals who have less sexual contact and drug users who do not share needles as often. There also may be changes in sexual practices or needle use.

In early 1982, it took about one year for the number of infected persons to double. The doubling time has now increased to about two years. Even if it increases to three years by 1991, I still estimate that a total of 2.5 million persons will be infected.

Unless the incubation period is altered by new anti-viral drugs, the estimated path of HIV infection will result in 23,000 cases of AIDS per quarter by early 1991. This means an additional 210,000 cases

beyond those diagnosed so far. Even if the spread of the virus comes to a complete halt today, there are already enough infected people to yield 180,000 more cases by 1991.

Heterosexuals and AIDS

In its report of April 6, 1987, the CDC listed 1,270 AIDS cases presumed to have arisen from heterosexual transmission. These represent 3.7 percent of all cases on record. An additional 1,053 adult cases, or 3.2 percent, were classified as "undetermined."

How many of the cases in these two categories are genuinely caused by heterosexual transmission of HIV in the United States? Among the 1,270 patients reported as heterosexual, 633 had no documented contact with an infected person. They were classified as heterosexual because they came from Africa or Haiti, where HIV infection rates are much higher, and where heterosexual transmission is believed to play a significant role. These persons may be truly heterosexual, but they are not in the American second-hit group.

What about the "undetermined" cases? Most appear to be first-hit persons who died or were otherwise lost to follow-up. Moreover, some are American men who have reported only contact with a "prostitute," and many of these prostitutes are likely to have been males. In a recent study by health-department officials in Colorado, 20 military men were identified as infected by HIV. When they were interviewed by other enlisted personnel, 12 claimed heterosexual contact as their source of infection. But when they were re-interviewed by civilians, they described homosexual and bisexual practices.

In my analysis, I let the category of "heterosexual" include all CDC-defined heterosexual cases infected in the United States—that comes to 637 people—

plus 15 percent of the "undetermined" group. As of April 6, 1987, this gives us a total of 795 heterosexual cases, which comprise 2.4 percent of all reported cases.

We know that heterosexuals can sexually transmit the virus to each other, and there has been considerable concern about the rate at which they are doing this. However, my research suggests that transmission from the first-hit groups—bisexual men and intravenous drug users—accounts for the growth of HIV infection in heterosexuals so far. The danger is that, in the future, the second-hit heterosexual population could grow sufficiently large to permit the "double hit"—significant numbers of heterosexuals giving the infection to each other.

Working backward from the data on AIDS in heterosexuals, I reconstructed the earlier spread of heterosexual infections. Then, by comparing the number of new heterosexual infections to the number of first-hit people already infected, I found that 4 new heterosexual infections arose per 1,000 infected first-hit persons every year. To interpret this figure, suppose that only one-quarter of first-hit infected persons are bisexual men or heterosexual intravenous drug users. And let's say these people average 5 heterosexual partners per year. So for every 1,000 persons in the first-hit group, 250 have a total of 1,250 heterosexual partners and 4 of the 1,250 partners become infected. Thus, the proba-

bility that a heterosexual could be infected by sexual intercourse with an HIV carrier would be 0.3 percent per year. By contrast, an individual has a 20 to 50 percent probability of contracting gonorrhea or syphilis from a single sexual contact with an infected person.

A relatively low rate of transmission among heterosexuals is not incompatible with the available epidemiological data. A homosexual man appears to be most susceptible to infection when he is the receptive partner (or "bottom man") in anal intercourse, especially when there is local rectal bleeding around the time of ejaculation. The risk may be further increased by the sharing of rectal douches, the presence of an untreated venereal infection in the rectum, or the practice of receiving a full fist or various foreign objects into the rectum. The resulting interruption of body barriers against viral intrusion is less likely to occur in vaginal intercourse. Moreover, the current epidemiological data do not thus far support penile-oral contact as a potent means of viral transmission.

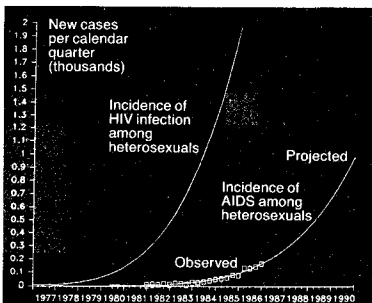
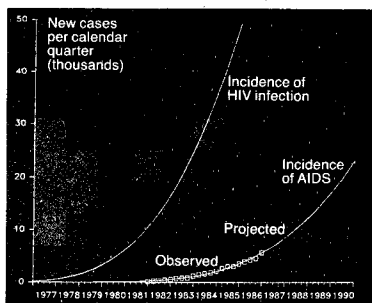
In a model where first hit to second hit is the main method of growth in heterosexual infection, I find that the number of second-hit infected heterosexuals is 30,000 by mid-1987. This comes to 0.017 percent of adults aged 15 and above in the United States. Such a rate of infection is comparable to that found in samples of blood donated for the first time by women.

For the next three or four years at least, the overwhelming majority of heterosexual AIDS cases will result from vaginal intercourse with a bisexual man or an intravenous drug user. If the first-hit group follows the path of infection described above, then those individuals will have transmitted HIV to a total of 120,000 heterosexuals by early 1991.

If the number of infected heterosexuals reaches 120,000, it is conceivable that spread from one heterosexual to another will be significant. Whether or not my future projections hold up, the key factor right now in preventing a heterosexual epidemic of AIDS in the United States is sex between first-hit and second-hit persons.

AIDS in Africa

Among adults in Zaire, Uganda, and other African countries, the proportion of HIV-infected adults is now 6 to 10 percent of the total population. Al-



Most people who will develop AIDS in the next three or four years have already been infected. While the first U.S. cases were not observed until 1981, the virus began to spread in 1977 (top graph). Now it has reached 900,000 Americans. Heterosexuals account for about 30,000 of those infected. In 1991, that number will have risen to 120,000, but only 9,200 will have come down with the disease by then (bottom graph).

*The sad fact is that people
who test positive for the AIDS virus
will become an underclass in our society.*

though false-positive blood tests may be a problem, all of the evidence indicates that HIV infection is over 100 times more prevalent among adults in these countries than in the U.S. Also, African men and women are infected in roughly equal numbers.

Is Africa merely five years ahead of us? While one study has indicated that Ugandan children had raised antibodies to HIV in 1972, more recent analyses have found no evidence of infection before 1975. A few specific cases of AIDS may have occurred in Africa in 1976 or 1977. Still, from the information we have now, we cannot conclude that the virus spread in Africa long before it reached the United States.

The evidence does point to heterosexual intercourse as an important means of transmitting HIV infection in many African countries. Although there are anecdotal reports of higher rates of sexual contact in Africa—particularly among more mobile, upper-class groups—the greater prevalence of untreated sexually transmitted infections may be the crucial distinguishing factor. For the partner who risks becoming infected with HIV, the coexistence of gonorrhea or syphilis may disrupt body barriers to the virus in much the same way that anal intercourse among homosexuals does. And for the partner who is already infected, a coexistent sexually transmitted disease may result in semen or cervical fluid with a larger number of lymphocytes—white blood cells of a certain type. Scientists now believe that HIV may be contained in these white blood cells when it is transmitted.

The lesson from Africa may be that medical care for gonorrhea, syphilis, chlamydia, herpes, and other venereal infections will be critical in controlling the spread of AIDS among heterosexuals in the U.S.

The Burden of AIDS

According to my forecast, there will be 210,000 more Americans with AIDS by 1991. Who will take care of these people? How much will it cost?

Recent studies place the lifetime medical-care costs for an AIDS patient at around \$50,000. At that rate, the cumulative cost of 210,000 additional cases in the next three to four years would exceed \$10 billion in current, undiscounted dollars.

At present, the life expectancy of a newly diagnosed AIDS patient is about one year. Therefore, only a fraction of the anticipated 210,000 new cases will be alive at any given time. If the life expectancy of

AIDS patients remains unchanged, then a total of 55,000 AIDS cases should be alive on a single day by early 1991. This amounts to about 10 AIDS patients for each hospital in the United States, or 6 patients for every 100 hospital beds. If improved treatment prolongs life but does not cure the disease, the number of living patients will be even higher. That will put enormous pressures on health-care facilities, particularly in urban centers such as New York, Los Angeles, and San Francisco, which have a highly disproportionate number of AIDS cases.

As the health-care burden of AIDS grows, so will the economic pressure on employers and insurance companies to identify and exclude people at risk for the disease. Already, insurance companies in some states are allegedly refusing to cover people who may be at high risk for HIV infection or who test positive for HIV, even when there is no sign of AIDS. And a number of employers have fired AIDS victims once their affliction has become known. Right now, the blood test for antibodies to HIV is available on a confidential or even anonymous basis. But confidentiality may well break down. Eventually, a negative test will have to be used to clear the name of anyone suspected of being infected. If employers, insurance companies, and prospective sex partners cannot use the blood test to identify infected people, they may attempt to find substitute means of identification. Insurance companies and employers, for example, might look at an applicant's marital status or location of residence. They might also note whether there has been a history of hepatitis, or whether the applicant has a low white blood count. Not only are these screening methods crude and imprecise, but they may cause many uninfected Americans to be denied employment or insurance. In the end, it will be a choice: use the HIV-antibody test or let these cruder "tests" prevail. Either way, the sad fact is that people who test positive will become an underclass. They will need special help from our society.

Currently, end-stage kidney disease is the only illness with its own federally sponsored insurance system. In all likelihood, AIDS will be second. As the medical burden of AIDS grows, so will the economic pressure on employers and health insurers. While the private sector might conceivably establish a fund for AIDS victims, I see some form of comprehensive government financing as inevitable. To have a fair, efficient system of financing in place for the 1990s, we need to start working out the details today. □