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A look at the latest AIDS projections for the United States
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As of the end of April 1990, 132,510 cases of acquired immunodeficiency syndrome (AIDS) had been diagnosed in the United States and reported to the U.S. Centers for Disease Control (CDC). In the first four months of 1990, 14,729 cases were reported to CDC, whose task it is to monitor the epidemic of human immunodeficiency virus (HIV) infection. Recent reports in the press and in the scientific literature have noted a slowing of HIV infection rates among some groups of homosexual men and intravenous drug users. A recent Public Health Service report stated, “It is now clear that the Nation is not dealing with a single epidemic of HIV infection with uniform characteristics. . . . The populations most affected and the resources available to treat and combat the spread of HIV may differ markedly from one geographic area to another.”

AIDS has presented new challenges to epidemiologists and others who do epidemiologic projections, for several reasons. First, transmission of
HIV is linked to specific actions. Rather than spreading randomly through the population, as, for example, an epidemic of influenza would, HIV spreads from host to host through contact with infected blood or semen. Second, unlike other sexually transmitted diseases, HIV infection possesses a long incubation period—two to ten years after initial HIV exposure. This makes it difficult to ascertain the increase in infection, without repeated antibody testing of the populations in question. Third, the HIV epidemic began at various points in time in different parts of the country, making it more difficult to track.

Problems in data collection. A major difference between the HIV epidemic and prior epidemics is its politically charged nature. In part because a cure for AIDS does not yet exist and in part because of the potential for discrimination against people identified as HIV-positive, problems exist in acquiring the data needed to project the epidemic's course accurately. These problems are compounded by lack of consensus among our nation's major institutions (employers, schools, churches, the health care system, insurers, and government at all levels) on how to respond to the HIV epidemic, despite the excellent recommendations of two national commissions and a well-respected surgeon general. Opposition from conservative quarters has blocked a National Center for Health Statistics project, the National Survey of Health and Sexual Behavior, whose aim is to gather nationwide baseline data on high-risk behavior, including sexual practices and drug use. Knowledge gained from this study would provide a sound basis for estimating the extent of HIV infection in different populations, if the rates of infection in these populations were known.

The implications of these data gaps are striking. A report released in June 1989 by the U.S. General Accounting Office (GAO) stated that problems with the quality and extent of data have “contributed to an underrepresentation of the epidemic in the national AIDS surveillance data and in most forecasts.” The current gap in our understanding of sexual and drug-using behavior stands in the way of accurate projections of HIV infection in certain populations and makes education programs for these groups more difficult to target.

All of these factors contribute to the complexity of formulating sound public health policy about HIV infection and AIDS. To aid in the policy making process, this DataWatch examines AIDS projections from a variety of sources.

The Numbers And What They Mean

In its report, GAO identified thirteen national forecasts of the cumu-
relative number of AIDS cases through the end of 1991. In examining these studies, the GAO team found “some problems with the comprehensiveness, empirical basis, or assumptions of each forecasting model.” It uncovered a range of forecasts from a lower bound of fewer than 100,000 cases by 1991 (which by mid-1989 had already been exceeded by actual reported cases) to an upper bound of 750,000. “Given the disparities among competing forecasts,” the report stated, “it is important that the underlying basis for the numbers be made clear and that, to the extent possible, a more realistic range be identified.”

GAO outlined four methods of projecting cases of AIDS: (1) extrapolation, which extends current trends in national surveillance of AIDS cases into the future; (2) back calculation, which looks backward from the number of reported AIDS cases, applying data on the incubation period and on the percentage of people who eventually develop AIDS, to determine the extent of HIV infection at a given point in time; (3) macro-level modeling, which supplements the above with assumptions about the future course of the epidemic at the societal level; and (4) micro-level modeling, which simulates behavior at the individual level that contributes to the spread of AIDS. The “best estimates” using the extrapolation model range from 200,000 to 350,000 cumulative AIDS cases by 1991; using back calculation, estimates range from 120,000 to 295,000. Macro-level estimates range from 160,000 to 400,000, and micro-level estimates converge around 250,000.

Centers for Disease Control projections. The most recent CDC projections of the course of the AIDS epidemic were derived using a combination of the extrapolation and back-calculation methods. In late fall 1989, CDC convened a workshop to evaluate, among other things, the way AIDS cases are projected. Workshop participants presented a variety of estimates, mostly based on back calculation; CDC then used that information to develop its current projections (Exhibit 1). According to these most recent estimates, between 390,000 and 480,000 new cases of AIDS will have been diagnosed by the end of 1993.

Several problems exist in using back calculation to project future AIDS cases. Such estimates depend on how one interprets the slowing in the rate of increase in reported cases that occurred in mid-1987. There are several possible explanations for this, according to Meade Morgan, chief of the Statistics and Data Management Branch at CDC. First, therapies such as zidovudine, or AZT, have had a measurable impact on the length of time between HIV infection and the onset of AIDS symptoms. This lengthening of the incubation period has affected the number of AIDS cases reported to CDC. Second, changes in behavior or saturation of the populations at greatest risk may be factors. A third possibility Morgan...
Exhibit 1
Projected Numbers Of AIDS Cases, Deaths Attributable To AIDS, And Living Persons With AIDS, Adjusted For Underreporting, 1989–1993

<table>
<thead>
<tr>
<th>Year</th>
<th>New cases</th>
<th>Alive</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>44,000–50,000</td>
<td>92,000–98,000</td>
<td>31,000–34,000</td>
</tr>
<tr>
<td>1990</td>
<td>52,000–57,000</td>
<td>101,000–122,000</td>
<td>37,000–42,000</td>
</tr>
<tr>
<td>1991</td>
<td>56,000–71,000</td>
<td>127,000–153,000</td>
<td>43,000–52,000</td>
</tr>
<tr>
<td>1992</td>
<td>58,000–85,000</td>
<td>139,000–188,000</td>
<td>49,000–64,000</td>
</tr>
<tr>
<td>1993</td>
<td>61,000–98,000</td>
<td>151,000–225,000</td>
<td>53,000–76,000</td>
</tr>
<tr>
<td>Through 1993</td>
<td>390,000–480,000</td>
<td>285,000–340,000</td>
<td></td>
</tr>
</tbody>
</table>


Note: Projections are adjusted for unreported diagnoses of AIDS by adding 18 percent to projections obtained from reported cases and rounded to the nearest 1,000.

Exhibit 2 compares CDC's original projections of AIDS case totals in 1987, 1988, and 1989 to the number of actual reported cases for each of those years. The projections, which were published in 1986, were not adjusted for underreporting; thus, to enable a comparison between the two sets of numbers, the case totals also are presented in unadjusted form. Currently, CDC inflates its number of AIDS cases reported by 18 percent to account for underreporting.

The “AIDS deficit.” Mitchell Gail, Philip Rosenberg, and James Goedert recently explored this “AIDS deficit” in greater detail Exam
ing the various explanations for the declining rate of increase, they found greatest evidence in support of the effect of therapy on the latency period of HIV infection to AIDS. This has important implications for future projections of AIDS cases, Gail said. Although fewer cases of AIDS are being reported, it does not necessarily follow that HIV infections have declined. The latter number, not the former, determines the future path of the epidemic. “Thus, projections that rely on AIDS cases reported after 1987 may understate the number of cases,” Gail said.16

According to Morgan, while CDC will continue to factor the effects of therapy in its projections, “it is important to realize that there is uncertainty inherent in any projection. However, while CDC is uncertain of the precise number of cases diagnosed, we still have a good idea of where the epidemic is going.”17

Other forecasting models. While CDC's projections are the most widely cited, other credible models exist as well. Of the four methods used to predict the course of the AIDS epidemic, the GAO report found micro-simulation models to be “the most comprehensive but, at present, lacking} a sound empirical base. Until the necessary empirical studies are conducted to provide this base,” the report continued, “it would be difficult to specify a preferred forecasting method.” The report's authors presented their most realistic range of cumulative cases as between 300,000 and 485,000 by the end of 1991.

The study then prescribed three areas that must be addressed if forecasters are to make their projections more accurate. First, current surveillance systems must be improved to correct a “sizable net underrepresentation” of cases that currently prevents “plausible forecasts.” According to Morgan, CDC, together with selected state and local health departments, is addressing this by way of “validation studies” currently under way in the field. These studies look at other sources of data—such as hospital discharge records, Medicare and Medicaid data, and the National Death Index—to capture cases that may not have been reported to CDC through its voluntary surveillance network.

A second GAO-recommended approach to improving forecasts is to “facilitate sharing of information” about the epidemic by making CDC's public use data set and documentation more widely available. An example of the importance of this lies in the fact that several forecasters GAO studied “assumed away” the possibility of heterosexual transmission, because detailed data on this mode of transmission were not available to them. According to Morgan, the next release of the CDC AIDS prevalence data will provide the level of detail on heterosexual transmission recommended by GAO.18

Finally, GAO advised that “a sound empirical base should be pro-
vided for the most comprehensive forecasting models—that is, the micro-simulation models.” To do this, the report recommended that the secretary of health and human services “review existing and ongoing empirical studies of individual risk-group behaviors as well as of HIV transmission and the current level of HIV infection to determine where additional data are most needed.”

**More conservative estimates.** In 1988, Joel Hay and his colleagues at Stanford University's Hoover Institution published a more conservative set of projections based on CDC data. In 1991, they projected, 51,000 new cases of AIDS will be diagnosed and reported; CDC's figure for that year is 56,000–71,000 (Exhibit 1). Hay's cumulative forecast of 230,000 cases by 1991 falls short of CDC's forecast as well. This difference is largely attributable to Hay and colleagues' assumptions about the rate of progression from HIV infection to frank AIDS.

Using an epidemiologic model produced by British epidemiologist William Farr in 1840, Alexander Langmuir and Dennis Bregman recently reported in the *Journal of the American Medical Association* that the AIDS epidemic crested late in 1988 and will continue to decline into the 1990s. They projected that the total number of AIDS cases would peak around 200,000—considerably fewer than others have posited. Bregman and Langmuir defended their approach, which sparked controversy when first presented in 1985, saying that “the analogy between Farr's cattle plague epizootic and the present AIDS epidemic in the United States is sufficiently close to warrant careful study.” Applying Farr's “simple, but elegant, arithmetic method of fitting a normal curve to the combined data,” to recent CDC AIDS prevalence data, they projected a decline in new AIDS cases through 1995, at which time “the incidence falls symmetrically to an annual incidence of fewer than 1,000 cases.”

Langmuir and Bregman qualified their findings as “a crude first approximation.” They continued, “In spite of problems with the lag in reporting cases and the change in diagnostic criteria in September 1987 [both of which can skew prevalence projections], we believe the AIDS epidemic has crested and will steadily decline.” They concluded, “The passage of time, perhaps only 1 more year, will serve to confirm or refute [the] . . . validity” of Farr's law applied to AIDS.

Many longtime observers of the HIV epidemic have sharply criticized Bregman and Langmuir's projection method. Mitchell Gail and Ron Brookmeyer, in an editorial in the same issue of the *Journal of the American Medical Association*, found “no particular justification . . . for why this curve should describe incidence for a disease such as AIDS, which has a long and variable incubation period.” In another editorial, Meade Morgan, James Curran, and Ruth Berkelman of CDC explained,
“Farr's law applies to epidemics that involve a closed group of individuals at risk and a new infection that spreads from infected to uninfected persons at a constant rate. In this situation, the spread of disease will follow a logistic incidence curve that is bell shaped... However, the spread of HIV is more complex.”

An article in the 16 March 1990 edition of The Wall Street Journal reported concern among AIDS activists that such projections, if given wide credence, could harm future funding for AIDS research and patient care.

CDC's Morgan added that Farr's law “fails to account for continuing new infection,” which serologic testing among military recruits shows is still happening. Langmuir's projection that the epidemic peaked in 1988 has already been proved inaccurate. More new cases of AIDS were reported to CDC in each month of the first quarter of 1990 than in any month since cases have been reported to CDC. "We take this as continuing evidence that epidemic has not stopped," Morgan said. Until the number of deaths from AIDS exceeds the number of new cases, the epidemic curve will continue to climb.

Conclusion

Although the specific numbers differ, clearly the most credible projections of future incidence of HIV infection agree on one thing: the AIDS epidemic is not going away any time soon. Even if no new HIV infections took place, the curve of disease incidence would still climb upward as those already infected (estimated to be around one million Americans) gradually developed symptoms of AIDS. Currently, around half of HIV-positive people develop AIDS symptoms. According to CDC, “The annual toll of AIDS cases and the nationwide burden of HIV-related disease will continue to grow, requiring further prevention efforts and increased medical and social services for the next several years.”

The author thanks Meade Morgan, U.S. Centers for Disease Control, and James A. Wells, Project HOPE Center for Health Affairs, for valuable assistance in the preparation of this DataWatch.

NOTES

2. Ibid.
7. TA. Peterman and L.R. Peterson, “Stalking the HIV Epidemic: Which Tracks to Follow and How Far?” American Journal of Public Health 80, no. 4 (April 1990): 401–402. Because surveillance of AIDS cases tracks only the end stage of HIV infection, the authors suggest, it must be supplemented by other efforts, such as repeated antibody testing and tracking indicators of AIDS risk, to provide a more complete picture of the current and future extent of the HIV epidemic.
12. Meade Morgan, chief, Statistics and Data Management Branch, US. Centers for Disease Control, Atlanta, Georgia, personal communication, 9 April 1990.
16. Mitchell H. Gail, Epidemiology and Biostatistics Program, National Cancer Institute, Rockville, Maryland, personal communication, 6 April 1990.
18. Ibid.
20. Ibid., for a complete discussion of the prevalence and seroconversion rates.
26. Ibid.