19. Berlin, B., Hingson, R., Strunin, L., and Heeren, T.: Changes in adolescent condom use, knowledge and beliefs about AIDS in Massachusetts, 1986–1990. Presented at Sixth International Conference on AIDS, San Francisco, CA, June 1990.
20. Anderson, J., et al.: HIV/AIDS knowledge and sexual behavior among high school students. Fam Plann Perspect 22: 252–255 (1990).
21. Moran, J., James, H., Peterman, T., and Stone, D.: Increases in condom sales following AIDS education and publicity, United States. Am J Public Health 80: 607–609 (1990).
22. Forrest, J. D., and Singh, S.: The sexual and reproductive behavior of American women, 1982–88. Fam Plann Perspect 22: 206–214 (1990).
23. Rosenbaum, E., and Kandel, D.: Early onset of adolescent sex and drug use. J Marriage Fam 52: 783–798 (1990).
24. Osgood, D. W., Johnson, L. D., O'Malley, P., and Bachman, J.: The generality of deviance in late adolescence and early adulthood. Am Sociol Rev 53: 81–91 (1988).
25. Miller, H., Turner, C., and Moses, L., editors: AIDS: the second decade. National Academy Press, Washington, DC, 1990, pp. 147–252.
26. General Accounting Office: AIDS education: programs for out-of-school youth slowly evolving. GAO/HRD-90-111. U.S. Government Printing Office, Washington, DC, May 1990.

The Potential Efficiency of Routine HIV Testing of Hospital Patients—Data from a CDC Sentinel Hospital

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Synopsis

St. Paul-Ramsey Medical Center is a member of the Centers for Disease Control (CDC) Sentinel Hospital Surveillance Group. The authors have modified the surveillance group's protocol in order to calculate what percentage of the human immunodeficiency virus (HIV)-infected samples identified came from persons known by them to be HIV infected. All identifiers are still unlinked from the sample before testing for HIV.

After 24 months, the HIV seroprevalence was 0.96 percent and the estimated cost of identifying a "new" seropositive at this site is $4,530 to $9,060. This range is a cost estimate; a typical laboratory charge for the HIV ELISA screen, if applied to such a testing program, would considerably increase this estimate.

Modifications to the protocol design that would target patients in certain demographic groups (for example, men ages 15 to 44 years) or HIV-associated diseases might improve efficiency but could miss a significant number of HIV-infected patients. The efficiency of hospital-based HIV testing would likely decline after several years of practice. Although there are significant ethical problems with programs attempting routine hospital-based HIV testing, pilot testing may merit consideration in areas where the HIV-1 seroprevalence is greater than 1 percent.

THE INTRODUCTION TO CLINICAL practice of testing for antibody to the human immunodeficiency virus (HIV) has led to controversy about its use. An unofficial consensus has developed recommending that patient consent and counseling be used in conjunction with the test (*1–4*), Two developments have prompted us to reexamine the issue. First, clinical advances in HIV care can provide benefit to persons even at an early state of infection (*5*). Second, data from the Centers for Disease Control's (CDC) Sentinel Hospital Project found high levels of HIV infection endemic in some areas, which led to the following conclusion—"there is a need for routine screening of HIV infection among some groups of patients, regardless of presentation" (*6*). As one of the participating sites in the CDC's sentinel project, we examined our data to determine seroprevalence and cost estimates.

Methods

The CDC Sentinel Hospital Surveillance Group includes approximately 40 short-stay hospitals located in 31 metropolitan areas in the United States and Puerto Rico. The protocol originally involved random sampling, on a monthly basis, of 300 leftover aliquots of serum or plasma already collected for other purposes. These samples involved inpatients and outpatients of all ages (half male, half female) with clinical conditions that were presumably unrelated to HIV infection. All identifiers are stripped before the samples are tested for HIV.

St. Paul-Ramsey Medical Center (SPRMC) began site participation in September 1988. SPRMC is a public teaching hospital in an urban location and is affiliated with the University of Minnesota. Our inpatient admissions numbered 12,711 in 1989, with 308,615 emergency room and clinic visits.

From September 1988 through August 1989, our site followed the original protocol guidelines. In September 1989, our protocol was modified to screen up to 500 samples per month, with no exclusions made on the basis of the admitting diagnosis. Therefore, samples from patients who were seen for HIV-AIDS or diagnoses associated with higher risk for HIV infection (for example, drug abuse) were allowed to remain in the sampling pool.

Under the protocol, a tested sample is ineligible for retesting until 1 year after protocol initiation. Therefore, the eligibility pool at our site became progressively smaller from September 1988 to August 1989. In September 1989 all samples were again eligible. In January 1990, our sampling frame was again refreshed as all sentinel hospitals were asked to restart their 12-month sampling frames to coincide with a calendar-year period.

To our knowledge, all 290 persons who were known by any of the SPRMC clinical or laboratory staff to be HIV seropositive were entered into the data base maintained by the HIV/AIDS Program at SPRMC. We have altered our protocol procedures so that, before HIV testing is performed, the medical record numbers of the selected samples are compared to the medical record numbers of the HIV positive patients reported to the HIV/AIDS Program. This comparison allows determination of the number of samples to be tested that are already known to be positive, and it allows determination of the number of HIV seropositive samples from the study that are unknown to the clinic. Before testing occurs, these medical record numbers are stripped from the samples; therefore, test results cannot be linked to persons.

'Our lowest estimate for the cost for an HIV screening program at our site in the absence of counseling is approximately $10 per test (laboratory costs only).'

Results

Seroprevalence. From September 1988 through August 1989 when the original protocol was followed, 4 of 3,560 samples at our site (0.1 percent) were confirmed by Western Blot testing to be HIV positive. After instituting the modified protocol, from September 1989 through August 1990, 88 of 5,967 samples at our site (1.5 percent) were confirmed by Western Blot testing to be HIV positive. Therefore, 92 of 9,527 samples (0.96 percent) were HIV positive. Seventy-seven of the 92 samples (83.7 percent) were from patients currently or previously seen in the HIV clinic, while 15 (16.3 percent) were from patients not known to be HIV seropositive. It is not known how many of these 15 are aware of their HIV serostatus, since the tests cannot be linked to individual patients and followup is therefore not possible.

Cost. Our lowest estimate for the cost for an HIV screening program at our site in the absence of counseling is approximately $10 per test (laboratory costs only). Other direct labor costs (project organization, confirmatory Western Blot testing, and record keeping) as well as indirect costs (as necessary for the CDC project at our site) would approximately double this figure to $20 per test. Assuming that none of the 15 HIV seropositive patients not known to the HIV/AIDS Program knew of their HIV positive serostatus, the approximate cost of identifying 1 "new" HIV positive patient at our site would be $6,350 to $12,700—1 "new" positive for every 635 samples tested ($10 to 20 per test × 635 samples per "new" positive).

Because in the first year of the study the protocol excluded potentially high-risk persons based upon admission diagnosis, the cost figures given previously for the first 2 years of the study provide inflated cost estimates for a hypothetical hospital-based screening program. A more accurate estimate may be produced by using only the second

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year of the study in its modified protocol format, since during Year 2 all specimens were eligible regardless of admitting diagnosis. Seventy-five of the 88 specimens (85.2 percent) which tested positive in Year 2 were from patients currently or previously seen in the HIV clinic, while 13 of the 88 (14.8 percent) were from patients not known to be seropositive. The discovery of these 13 HIV-infected specimens was the result of testing 5,967 specimens in Year 2, or 1 positive for every 459 patients tested. Since in a hospital-based screening program there would have been no need to test the 75 known positives, these 75 can be subtracted from the 5,967 tested in Year 2, leaving 5,892 that would have been tested to discover the 13 "new" positives, or 1 new positive for every 453 specimens. Therefore, a more accurate cost approximation for identifying 1 potentially "new" HIV positive would be $4,530 to $9,060 ($10 to $20 per test × 453 samples).

Discussion

SPRMC has reported 10.7 percent of the known HIV-AIDS cases within Minnesota to the Minnesota Department of Health. SPRMC has 2.46 percent of Minnesota's hospital admissions so there is a relative 4.3-fold (10.7 ÷ 2.46) overrepresentation of HIV at SPRMC compared with the State average. The efficiency of routine hospital based HIV screening would likely be lower in most other hospitals in Minnesota.

Overall program costs, as well as the cost per "new" positive, could be further reduced by testing specimens only from those age or sex groups more likely to be sexually active or using IV drugs (ages 15–44). This type of restriction would considerably decrease the number of tests performed, since most hospital inpatient and outpatient populations are weighted by a disproportionate fraction of elderly adults, whereas the CDC protocol conducted in our hospital is stratified so as to be representative of U.S. population demographics, not hospital inpatient demographics. In addition, subtracting the costs of maintaining these data in a format suitable for the CDC, as is done in this site, would slightly reduce costs.

A second consideration for cost reduction would be to increase the program's efficiency by testing only those persons who present with an admitting diagnosis considered to be associated with a higher risk for HIV infection. If this strategy were employed within our hospital by using the CDC's definition of higher risk diagnoses during Year 2 of the study, then 2,355 specimens would have been tested, only 39 percent of the 5,967 that were actually tested in Year 2 of the study.

Even with such a significant reduction in the number of tests, such a testing program would still have detected 11 of the 13 "new" positives (85 percent) that were discovered in the second year of our study. Eleven positives out of 2,355 translates to 1 "new" positive for every 214 specimens tested. With the same cost estimates of $10 to $20 per test, then the average cost of discovering a single new positive is now reduced to a range between $2,140 and $4,280. However, those persons presenting with diagnoses not deemed to be associated with a higher risk for HIV infection would not be tested in such a program. If this were applied to Year 2 of our study, then 2 of the 13 potential ""new" positives which were found in Year 2 would have been missed.

The cost reduction measures just outlined would be offset by personnel costs necessary for the provision of counseling and followup services to those patients who test positive. Further, the cost efficiency of such a testing program would be sharply reduced as the program aged, since the first year of the program's existence would be, in effect, a detection of HIV prevalence, with subsequent years producing a measure of HIV incidence. Over a short period, this would drive up the average cost of discovering a "new" (unknown) HIV-infected patient, since relatively more patients would have to be tested to detect a single HIV positive which was previously unknown to the system.

This paper is intended to provide estimates of the cost of a hospital-based HIV antibody screening program, and it does not take into account the actual charges that hospital laboratories typically charge for HIV antibody testing. At our hospital, the charge to a patient for a single ELISA antibody test is $34; many hospitals levy similar or higher charges. If the same charge were applied to a screening program at our hospital, then the cost of "discovery" of a single "new" HIV positive pa-

tient would rise to $15,402 (453 tests × $34 per test); this sum excludes charges for post-test counseling and evaluation. The cost to identify each HIV seropositive person may vary considerably depending on the type of clinical setting. For example, at a private hospital in Houston, TX, an effort was made to voluntarily test all admissions for HIV (*7*). The estimated cost for each HIV seropositive person identified was $14,550 despite the fact that Texas has a much higher incidence of AIDS than Minnesota (18.4 versus 4.3 per 100,000) (*8*). Further analysis of that report indicates that the estimated cost to identify each HIV-infected person who would have been clinically "unsuspected" was $43,649 (453 × $38.50 per test). Thus, discussion of the institution of "routine" HIV testing in the clinical setting is likely to include issues such as local HIV seroprevalence, hospital demographics, the ethics of testing with minimal or no pretest counseling or specific consent, and the economics of the cost within the context of screening for other health problems (that is, Papanicolaou smears, mammography, and so forth). It is our concern that routine hospital-based HIV testing, if used widely and indiscriminately, will shunt valuable public health dollars from more useful HIV-related programs such as education, research, and clinical care.

We do not advocate routine hospital-based testing but believe that pilot testing in areas of varying seroprevalence should be done to assess its potential merit. Routine HIV testing is likely to be more cost effective and to have greater clinical and public health benefits in areas of high HIV seroprevalence (that is, greater than 1 percent), but the ethical issues raised are a formidable obstacle (*9*). The pressure to test health care workers for HIV, which has intensified after the case report of the possible HIV transmission in a dental office in Florida, is also likely to increase the desire of health care workers to test patients for HIV (*10,11*). Before any recommendations are made, public policy decision makers should carefully consider the relative effectiveness of HIV screening in various settings.

References

1. Henry, K., et al.: Nondonor HIV antibody testing in Minnesota. N Engl J Med 315:581–582, Aug. 28, 1986.
2. Henry, K., Maki, M., and Crossley, K.: Analysis of the use of HIV antibody testing in a Minnesota hospital. JAMA 259:229–232, Jan. 8, 1988.
3. Henry, K., Willenbring, K., and Crossley, K.: Human immunodeficiency virus antibody testing. JAMA 259:1819–1822, Mar. 25, 1988.
4. Eickhoff, T.: Hospital policies on HIV antibody testing. JAMA 259:1861–1862, Mar. 25, 1988.
5. Rhame, F., and Maki, D.: The case for wider use of testing for HIV infection. N Engl J Med 320:1248–1254, May 11, 1989.
6. St. Louis, M., et al.: Seroprevalence rates of human immunodeficiency virus infection at sentinel hospitals in the United States. N Engl J Med 323:213–218, July 26, 1990.
7. Harris, R.L., Boisaubin, E.V., Salyer, P.D., and Semands, D.F.: Evaluation of a hospital admission HIV antibody voluntary screening program. Infect Control Hosp Epidemiol 11:628–634, December 1990.
8. Centers for Disease Control: HIV/AIDS surveillance report. December 1990, pp. 1-l8.
9. Rhame, F.S.: Hospital-based routine HIV testing programs. Infect Control Hosp Epidemiol 11:625–627, December 1990.
10. Possible transmission of human inmmunodeficiency virus to a patient during an invasive dental procedure. MMWR 39:489–493, July 27, 1990.
11. Update: transmission of HIV infection during an invasive dental procedure—Florida. MMWR 40:21–27,33, Jan. 18, 1991.