Do People Who Develop AIDS within 12 Months of HIV Diagnosis Delay HIV Testing?

SANDRA K. SCHWARCZ, MD,
MPH^{a,b}

LING HSU, MPH^a

CHI-SHENG JENNIE CHIN, MBA^a

T. ANNE RICHARDS, MA^c

HEIDI FRANK, MPH, MBA^{a,d}

CONRAD WENZEL, BA^a

JAMES DILLEY, MD^e

ABSTRACT

Objective. Individuals diagnosed with AIDS within 12 months of HIV diagnosis have been considered “late testers.” Prevalence estimates of late testers have been made using HIV/AIDS surveillance data, and high rates of late testing have been reported. However, studies evaluating this definition have not been conducted. We measured the degree of misclassification of delayed testing based on this surveillance definition of late testing.

Methods. We used dates of negative HIV tests among people who met this definition of late testing in San Francisco from 2007 to 2008 to reclassify people as “verified non-late testers” if there was a negative HIV test within five years of HIV diagnosis, as “verified late testers” if there were no prior tests or if negative tests were recorded five or more years prior to diagnosis, or as “late-tester status not verified.” We measured misclassification of late-tester status and the prevalence of late testing using the different definitions of late testing.

Results. Of the 270 people who developed AIDS within 12 months of HIV diagnosis, we found that 89 (33.0%) were verified late testers, 131 (48.5%) were verified non-late testers, and 50 (18.5%) were unverifiable. Using the surveillance definition (individuals who develop AIDS within 12 months of HIV diagnosis), the prevalence of late testing was 26.3%, whereas it was 9.0% when restricted to individuals verified as late testers.

Conclusion. Defining people who develop AIDS within 12 months of HIV diagnosis without taking into consideration the dates of prior negative HIV tests leads to substantial misclassification of late testing.

^aSan Francisco Department of Public Health, San Francisco, CA

^bUniversity of California, San Francisco, Department of Epidemiology and Biostatistics, San Francisco, CA

^cUniversity of California, Berkeley, Department of Natural Resources, Berkeley, CA

^dUniversity of California, San Francisco, Global Health Sciences, San Francisco, CA

^eUniversity of California, San Francisco, Department of Psychiatry, San Francisco, CA

Address correspondence to: Sandra K. Schwarcz, MD, MPH, San Francisco Department of Public Health, 25 Van Ness Ave., Ste. 500, San Francisco, CA 94102; tel. 415-554-9000; fax 415-431-0353; e-mail <sandy.schwarcz@sfdph.org>.

©2011 Association of Schools of Public Health

Late diagnosis of human immunodeficiency virus (HIV) infection is associated with increased morbidity, mortality, and health-care costs.¹⁻⁵ HIV transmission may also be increased by late diagnosis because people who are unaware of their infection may not realize the risk they present to others. Following HIV diagnosis, HIV risk behaviors have been shown to decrease.⁶⁻⁸ Therefore, enabling individuals to learn of their infection earlier in the course of the disease is a public health priority.⁹ The magnitude of late HIV diagnosis has been estimated using medical records^{10,11} or surveillance data.¹²⁻¹⁴ Although the definition of late testing varies, all studies have defined late diagnosis as the development of acquired immunodeficiency syndrome (AIDS) within a relatively short time from HIV diagnosis. These definitions are all based on a 10-year estimated average time from HIV diagnosis until the development of AIDS in the absence of antiretroviral therapy.¹⁵

The San Francisco Department of Public Health (SFPDH) has monitored trends in late HIV diagnosis since 2001.^{16,17} We have defined late testers as individuals who developed AIDS within 12 months of HIV diagnosis (hereafter referred to as the surveillance case definition of a late tester). In San Francisco, 24% of people who reported with HIV from 2003 to 2006 were late testers.¹⁷ The definition of late testing used in San Francisco is consistent with the definition used by the Centers for Disease Control and Prevention (CDC), except that we used the earliest date of any of the following criteria obtained from the medical record as the date of HIV diagnosis: the physician diagnosis of HIV, the first positive HIV test by laboratory or self-report, the first viral load/cluster of differentiation 4 (CD4) test, or the first prescription for antiretroviral therapy (excluding post-exposure prophylaxis). CDC uses only the date of physician diagnosis of HIV or the date of laboratory-confirmed HIV-positive antibody test, detectable HIV nucleic acid, or plasma HIV ribonucleic acid. CDC published data from 37 states and five territories with well-established HIV case reporting and showed that, in 2007, 32% of people reported with HIV developed AIDS within 12 months of HIV diagnosis,¹⁸ which is somewhat lower than the 38%–39% reported annually from 2002 to 2006.^{13,19-24}

Although it has been well documented that a small proportion of people develop AIDS opportunistic illnesses and/or low CD4 lymphocyte levels early in the course of HIV disease,²⁵⁻²⁷ the impact that this may have on the estimates of the prevalence of late testing has not been examined. We used the dates of prior negative HIV tests obtained from two sources—an interview study of late testers and a supplemental surveillance

system—to estimate the degree of misclassification associated with our standard definition of late testing.

METHODS

Interview study of late testers

To understand the factors that lead to late testing and to develop appropriate interventions to increase early HIV diagnosis, we conducted a qualitative and quantitative interview study (hereafter, Late-Tester Interview Study [LTIS]) of people who met our surveillance case definition of late testing. In this study, we used the San Francisco HIV/AIDS case registry to identify late testers who were diagnosed with AIDS and contacted their health-care providers, who recruited the patients to participate in the LTIS. Subjects were diagnosed with AIDS from January 1, 2007, through December 31, 2008, and reported to SFPDH through March 9, 2009.

After providing informed consent, participants were administered a qualitative interview in a private setting. The interview was conducted using a qualitative interview guide that covered a number of topics, including previous HIV tests. At the conclusion of the qualitative interview, participants were administered a structured questionnaire that also collected information on previous HIV tests. Interviews were conducted in English or Spanish, audio recorded, and transcribed verbatim. The coding and analysis of transcripts followed standard qualitative methods and included coding of the dates of previous negative HIV tests.²⁸

During the first few months of the LTIS, several participants reported that they had tested negative for HIV within a few years of HIV diagnosis. Because the purpose of the study was to collect information from people who delayed HIV testing, we modified our eligibility criteria to require that otherwise eligible people must not have reported a negative HIV test within the five years prior to HIV diagnosis. To exclude these individuals, we asked health-care providers to indicate those patients who had a negative test within the five years prior to HIV diagnosis.

Based on information from our initial interviews and from health-care providers, we classified people included in our original sample of late testers as “verified late testers” if there were no prior negative HIV tests or if the most recent negative HIV test was five or more years before HIV diagnosis. If the provider or participant reported a negative HIV test fewer than five years before HIV diagnosis, we classified them as “verified non-late testers.” All others in the sample were classified as “late-tester status not verified.” On occasion, the health-care provider indicated that, although

the patient met the surveillance case definition of AIDS because of a low CD4 count or percentage, the drop in CD4 cells was due to factors other than advanced HIV disease (e.g., seroconversion or use of steroids). We classified these individuals as “verified non-late testers.” In addition, we identified a few individuals in our sample whose date of HIV diagnosis was earlier than what was reported in the HIV/AIDS case registry; if the time between HIV diagnosis and AIDS was greater than 12 months, these individuals were also reclassified as “verified non-late testers.”

The LTIS was approved by the Institutional Review Boards of the following San Francisco hospitals: the University of California, Kaiser Permanente, St. Mary’s Medical Center, and the Veterans Administration.

HIV incidence surveillance

San Francisco is one of 34 areas (30 states, three cities, and Puerto Rico) funded by CDC to conduct HIV incidence surveillance (HIS). Details of this system have been described elsewhere.^{29,30} In this supplemental surveillance system, remnant blood from people newly testing positive for HIV is retested at a regional laboratory using an HIV antibody test that is less sensitive than standard diagnostic antibody tests. People who test negative on the less sensitive test are classified as recently infected. In addition to the information routinely collected for people reported with HIV infection, HIS ascertains any previous negative HIV test and the date of the last HIV negative test. The testing history is included in the HIV case report form, which is either submitted by the health-care provider or completed by health department personnel as part of active case surveillance activities.³¹ Documentation of the HIV testing history includes documented laboratory test results or patient self-report. We used the LTIS sample of individuals who met the surveillance case definition of late tester and applied the HIV testing history data contained in the incidence database to classify people as “verified late testers,” “verified non-late testers,” or “late-tester status not verified.”

Analysis

Using the original sample from the LTIS, we determined the proportion of people reclassified as verified late testers, verified non-late testers, and late-tester status not verified. We also used the HIS data to determine the proportion of people in the LTIS sample who were reclassified as late testers, verified non-late testers, and late tester status not verified. Because the HIS database includes the dates of the last negative HIV test, we calculated the proportion of verified non-late testers

whose last negative test was one, two, three, four, and five years prior to HIV diagnosis.

We calculated the proportion of late testers among HIV cases diagnosed from January 1, 2007, to December 31, 2008, and reported through March 9, 2009, using the LTIS data. In this analysis, we were able to calculate the percentage of late testing using three different definitions of late testing: (1) the surveillance case definition, (2) verified late testers, and (3) verified late testers plus people for whom the late-tester status could not be verified. In this analysis, we excluded late testers who were diagnosed with AIDS in 2007 and whose HIV diagnosis was in 2006.

In addition, we compared the characteristics of verified late testers with non-late testers and calculated the independent predictors of late testing. To identify a comparable group of non-late testers, we restricted our analyses to people diagnosed in 2007 and 2008. In this analysis, the verified late testers were compared with people diagnosed with AIDS in 2007 and 2008 whose HIV diagnoses were more than 12 months prior to their AIDS diagnoses (i.e., they did not meet the surveillance case definition of late testing). Included in the comparison group of non-late testers were the individuals we reclassified as verified non-late testers. We excluded participants for whom we could not verify late-tester status in this analysis. We compared characteristics using the Chi-square test and calculated the independent predictors of late testing using stepwise logistic regression, in which all variables were entered and retained if $p < 0.05$.

RESULTS

As shown in Table 1, 270 people met the surveillance case definition of late tester. Based on information obtained from the LTIS, 89 (33.0%) met our definition of verified late tester, 131 (48.5%) were verified as non-late testers, and 50 (18.5%) were unable to have their late-tester status determined. Using data from the HIS database, we found that 45 (16.7%) of the 270 people included were verified late testers, 81 (30.0%) were verified non-late testers, and 144 (53.3%) were unable to have their late-tester status verified. The HIS data identified 11 people who reported a prior negative test, but the date of the last negative test was missing and their late-tester status could not be verified. Among the verified non-late testers, 70 (86%) had a negative test within three years of HIV diagnosis and 36 (44%) tested negative within the 12 months prior to HIV diagnosis.

Using the surveillance case definition of late testing,

Table 1. Reclassification of late testers by date of last negative HIV test obtained from the SFDPH Late-Tester Interview Study and HIV Incidence Surveillance data, 2007–2008^a

Data source and late-tester status	Individuals who met the surveillance case definition of late tester (n=270)
	N (percent)
Late-Tester Interview Study	
Verified late tester	89 (33.0)
Verified non-late tester	131 (48.5)
Negative HIV test <5 years before HIV diagnosis	111
HIV diagnosis >1 year prior to AIDS diagnosis	15
Not AIDS ^b	5
Late-tester status not verified	50 (18.5)
HIV Incidence Surveillance	
Verified late tester	45 (16.7)
Verified non-late tester	81 (30.0)
Negative HIV-negative test 0–12 months prior to HIV diagnosis	36
Negative HIV test 13–24 months prior to HIV diagnosis	16
Negative HIV test 25–36 months prior to HIV diagnosis	18
Negative HIV test 37–48 months prior to HIV diagnosis	5
Negative HIV test 49–60 months prior to HIV diagnosis	6
Late-tester status not verified ^c	144 (53.3)

^aIncludes people diagnosed with AIDS from January 1, 2007, through December 31, 2008, and reported to the SFDPH through March 9, 2009, whose date of HIV diagnosis was within 12 months of the date of AIDS diagnosis, as listed in the San Francisco HIV/AIDS case registry

^bHealth-care providers indicated that these individuals did not have AIDS; includes people who had low CD4 counts or percentages for reasons other than delayed diagnosis, such as seroconversion or taking a short course of steroids.

^cIncludes 11 people who had a prior negative test, but the date of that test was not recorded; all others did not have information on prior HIV tests

HIV = human immunodeficiency virus

SFDPH = San Francisco Department of Public Health

AIDS = acquired immunodeficiency syndrome

CD4 = cluster of differentiation 4

we found that 26.3% (95% confidence interval [CI] 23.5, 29.2) of individuals diagnosed with HIV in 2007 and 2008 were late testers (Table 2). When we restricted the analysis to cases for whom we verified late-tester status, we found that 9.0% (95% CI 7.2, 10.8) of individuals diagnosed with HIV in 2007 and 2008 were late testers. It is likely that some people (if not the majority)

for whom late-tester status could not be verified did, in fact, delay testing. To estimate an upper limit of the prevalence of late testers, we considered participants whose late-tester status could not be verified as a true late tester. Under this assumption, 14.1% (95% CI 11.9, 16.3) of individuals diagnosed with HIV in 2007 and 2008 were late testers.

Late testers were more likely than non-late testers to be nonwhite, heterosexual, reported without a transmission risk behavior, without health insurance at the time of diagnosis, born outside of the United States, and, compared with people whose initial AIDS diagnosis was a CD4 count of <200 cells/cubic millimeter (mm³) or <14%, diagnosed with AIDS because of an opportunistic illness or both a low CD4 count and percentage (Table 3). After adjusting for potential confounders, people who were heterosexual, without reported risk, lacking health insurance, born outside of the U.S., and whose initial AIDS diagnosis was either an opportunistic illness or a CD4 count of <200 cells/

Table 2. Prevalence of late testing before and after reclassification among people diagnosed with HIV in 2007–2008: San Francisco Department of Public Health Late-Tester Interview Study^a

Characteristic	N	Late testers among all HIV cases diagnosed in 2007–2008 (n=945)
		Percent (95% CI)
Met the surveillance case definition of a late tester: developed AIDS within 12 months of HIV diagnosis ^b	249	26.3 (23.5, 29.2)
Verified late tester: developed AIDS within 12 months of HIV diagnosis and did not have a negative HIV test <5 years before HIV diagnosis	85	9.0 (7.2, 10.8)
Verified late tester and late-tester status not verified: developed AIDS within 12 months of HIV diagnosis and did not have a negative HIV test <5 years before HIV diagnosis, and people for whom information on prior tests was not available	133	14.1 (11.9, 16.3)

^aReported through March 9, 2009

^bExcludes 21 people who were diagnosed with HIV in 2006 and diagnosed with AIDS in 2007

HIV = human immunodeficiency virus

CI = confidence interval

AIDS = acquired immunodeficiency syndrome

mm³ and percentage <14% remained at higher risk for late testing. People missing information on health insurance had an increased risk of being a late tester, but the number of these individuals was small.

DISCUSSION

Our findings indicate that the definition of late testing that we¹⁶ and others^{13,32} have used substantially misclassifies late testers. Including dates of most recent

Table 3. Characteristics and independent predictors of late testing among people diagnosed with HIV in 2007–2008: San Francisco Department of Public Health Late-Tester Interview Study^a

Characteristic	Verified non-late testers ^b (n=603)	Verified late testers (n=89)	P-value	Adjusted odds ratio (95% CI)
	N (percent)	N (percent)		
Age at diagnosis (in years)			0.5462	
13–29	70 (11.6)	15 (16.9)		
30–39	182 (30.2)	24 (27.0)		
40–49	225 (37.3)	33 (37.1)		
≥50	126 (20.9)	17 (19.1)		
Gender			0.8686	
Male	540 (89.6)	79 (88.8)		
Female	46 (7.6)	8 (9.0)		
Transgender	17 (2.8)	2 (2.3)		
Race/ethnicity			0.0368	
White	356 (59.0)	39 (43.8)		
Black	102 (16.9)	17 (19.1)		
Latino	91 (15.1)	21 (23.6)		
Other	54 (9.0)	12 (13.5)		
Risk group			<0.0001	
Male-male sex	396 (65.7)	50 (56.2)		Referent
Injection drug use	57 (9.5)	7 (7.9)		
Male-male sex and injection drug use	108 (17.9)	9 (10.1)		
Heterosexual	31 (5.1)	15 (16.9)		4.0 (1.9, 8.3)
No reported risk	11 (1.8)	8 (9.0)		6.1 (2.2, 17.2)
Insurance at time of diagnosis			0.0001	
Public	225 (37.3)	29 (32.6)		Referent
Private	264 (43.8)	26 (29.2)		
None	110 (18.2)	31 (34.8)		2.6 (1.5, 4.4)
Unknown	4 (0.7)	3 (3.4)		8.1 (1.6, 40.1)
Homeless at diagnosis	49 (8.1)	6 (6.7)	0.6522	
Country of birth			<0.0001	
U.S.	483 (80.1)	60 (67.4)		Referent
Outside U.S.	72 (11.9)	26 (29.2)		2.4 (1.4, 4.3)
Unknown	48 (8.0)	3 (3.4)		
Initial AIDS diagnosis			<0.0001	
Opportunistic illness	56 (9.3)	15 (16.9)		4.6 (2.2, 9.9)
CD4 count <200 cells/mm ³ and CD4 percentage <14% ^{c,d}	177 (29.4)	53 (59.6)		4.8 (2.7, 8.4)

^aExcludes people whose late-tester status was not verified

^bIncludes people diagnosed with AIDS between January 1, 2007, and December 31, 2008, whose HIV diagnosis was more than 12 months prior to their AIDS diagnosis

^cIn the absence of an opportunistic illness

^dIncludes one verified late tester and five non-late testers who had a CD4 count <200 cells/mm³ but did not have a CD4 percentage recorded

HIV = human immunodeficiency virus

CI = confidence interval

AIDS = acquired immunodeficiency syndrome

CD4 = cluster of differentiation 4

mm³ = cubic millimeter

negative HIV test and verifying dates of HIV and AIDS diagnoses indicated that only one-third of the individuals we believed to have delayed testing were, in fact, late testers. If we assume that all of the people for whom we could not verify late-tester status did, in fact, delay testing, we find that half of the individuals were misclassified as late testers. Consequently, our findings indicate that the prevalence of late testing among people diagnosed with HIV in San Francisco for the years 2007 and 2008 ranged from 9.0% to 14.1%, more than 60% lower than our previously published estimate of 24%.¹⁷

Although we found a substantially lower prevalence of late testing than we previously reported, both analyses identified the same factors that were independently associated with an increased likelihood of testing late, with the exception of age. In our previous analysis, people aged 13–29 years had nearly twice the risk of testing late; in our current analysis, age did not independently predict late testing.¹⁶

In our current analysis of the independent predictors of late testing, we compared the verified late testers with verified non-late testers. It is possible that the people for whom late testing status could not be verified were in fact late testers. To assess the impact that excluding these individuals had on this analysis, we assumed that all people with unverified late-testing status were late testers and examined the independent predictors using this larger sample. Although the magnitude of the odds ratio differed, the factors associated with increased likelihood of late testing were the same, with the exception of age. When we included people with unverified late-tester status, we found that people aged 30–39 years had a lower risk of late testing compared with people aged 40–49 years, and that none of the other age groups had a statistically significant association with late testing.

Limitations

There were several important limitations to this analysis. The information used to determine late-tester status was obtained from our interviews with patients, from notation of HIV testing dates and diagnosis in the medical records that was obtained by self-report of patients to their health-care providers, and from the health-care providers directly. Bias associated with recall of past events and social desirability may have affected the responses from patients, which we were unable to validate. However, we obtained the HIV testing histories in the LTIS in an extensive qualitative interview during which rapport was established between the interviewer and participant and in which the participant was asked to provide a detailed account

of the factors surrounding his/her HIV/AIDS diagnosis, source of infection, testing history, and health-care behavior. Thus, the information on previous HIV tests came as the participant's story unfolded, with ample opportunity for the participant to provide confirmatory or contradictory information. In addition, review of the transcripts was able to identify any discrepancies in the participant's interview. Further, we measured the correlation between HIV testing history obtained from the qualitative and quantitative interviews and found that they correlated well (Cronbach coefficient = 0.95). Although information on HIV testing history obtained from incidence surveillance was missing from more than half of the participants, those data also found a higher proportion of verified non-late testers than verified late testers, supporting the findings from the LTIS.

Defining a late tester as having either never been tested for HIV or having tested negative for HIV five or more years before HIV diagnosis was somewhat arbitrary, given that there are no standard definitions of late testing that take into account prior negative tests. One might argue that using a shorter time period between the last negative test and diagnosis would better distinguish late testers from non-late testers. Yet, we found that the dates of the last negative test obtained from incidence surveillance indicated that most of the misclassified late testers reported a negative test within the three years prior to HIV diagnosis, suggesting that narrowing the time period between prior negative tests and diagnosis would not have had a large impact on our findings.

We defined people who had never tested for HIV prior to diagnosis as late testers. Because we had no information on when these individuals acquired HIV, we could not determine the length of time between seroconversion and HIV diagnosis. It is possible that some of these people were in fact recently infected, which would indicate an even lower prevalence of late testing than presented in this article.

A final limitation was that this study was conducted in a single jurisdiction and during a relatively short time frame. As such, for our findings to be representative of other areas, this study must be repeated elsewhere.

CONCLUSION

Although the aim of this analysis was to evaluate misclassification associated with surveillance case definitions of late testing, the findings have implications beyond surveillance. Most notably, additional studies to estimate the prevalence of and factors associated with rapid progression of HIV disease may be warranted.

We believe that our findings provide strong evidence that our previous definition of late testing does not accurately identify people who delayed diagnosis. Although we do not have data with which to assess misclassification of late testing in the U.S. or elsewhere, our findings suggest that the definitions of late testing that do not take into account prior negative tests are likely to misclassify late testers in other settings as well. We recommend that prevalence estimates of late testing include information on previous HIV tests. We did find that incorrect dates of HIV diagnosis also contributed to misclassification of late testers, but this was a relatively infrequent occurrence.

Although the date of last negative HIV test is a variable included in the national HIV/AIDS case report form, only test dates and results that are obtained from a laboratory report can be used. Of the people included in our original sample of 270 people who developed AIDS within 12 months of HIV diagnosis, only 9% had this information recorded on their HIV/AIDS case report form. Thus, we recommend including the self-reported date of the last negative HIV test as part of routine HIV/AIDS surveillance. While this change would likely result in more cases with information on previous negative tests, the data from incidence surveillance indicate that such information is either infrequently ascertained by the provider, ascertained but not included in the case report form submitted, or not noted in the medical record. Because our interviews with patients and providers did result in acquiring information on prior negative tests, we know that this information is available. As such, efforts to collect this information as part of routine HIV/AIDS surveillance must include follow-up contact with health-care providers to ensure complete ascertainment of testing history. More accurate estimates of late testing and descriptions of people testing late will help policy makers and HIV prevention providers design HIV testing messages for the at-risk population.

The authors thank the health-care providers who provided human immunodeficiency virus (HIV) testing information and referred their patients for the study; the study participants; Steven Follansbee, MD, C. Brad Hare, MD, and Mitchell H. Katz, MD, for their overall support of the study; and Dr. Katz for his critical review of the article. The authors also thank the HIV/acquired immunodeficiency syndrome surveillance and incidence surveillance staffs, whose work made this study possible.

This study was supported by Gilead Sciences, Inc. and the Centers for Disease Control and Prevention (CDC) (cooperative agreements #U62PS001-000-03 and #U62/CCU923478-03). The findings and conclusions in this article are those of the authors and do not necessarily represent the views of Gilead Sciences, Inc. or CDC.

REFERENCES

1. Chadborn TR, Delpech VC, Sabin CA, Sinka K, Evans BG. The late diagnosis and consequent short-term mortality of HIV-infected heterosexuals (England and Wales, 2000–2004). *AIDS* 2006;20:2371-9.
2. Hogg RS, Yip B, Chan KJ, Wood E, Craib KJ, O'Shaughnessy MV, et al. Rates of disease progression by baseline CD4 cell count and viral load after initiating triple-drug therapy. *JAMA* 2001;286:2568-77.
3. Krentz HB, Auld MC, Gill MJ. The high cost of medical care for patients who present late (CD4 <200 cells/microL) with HIV infection. *HIV Med* 2004;5:93-8.
4. Murphy EL, Collier AC, Kalish LA, Assmann SF, Para MF, Flanagan TP, et al. Highly active antiretroviral therapy decreases mortality and morbidity in patients with advanced HIV disease. *Ann Intern Med* 2001;135:17-26.
5. Sterling TR, Chaisson RE, Keruly J, Moore RD. Improved outcomes with earlier initiation of highly active antiretroviral therapy among human immunodeficiency virus-infected patients who achieve durable virologic suppression: longer follow-up of an observational cohort study. *J Infect Dis* 2003;188:1659-65.
6. Adoption of protective behaviors among people with recent HIV infection and diagnosis—Alabama, New Jersey, and Tennessee, 1997–1998. *MMWR Morb Mortal Wkly Rep* 2000;49(23):512-5.
7. Colfax GN, Buchbinder SP, Cornelisse PG, Vittinghoff E, Mayer K, Celum C. Sexual risk behaviors and implications for secondary HIV transmission during and after HIV seroconversion. *AIDS* 2002;16:1529-35.
8. Weinhardt LS, Carey MP, Johnson BT, Bickham NL. Effects of HIV counseling and testing on sexual risk behavior: a meta-analytic review of published research, 1985–1997. *Am J Public Health* 1999;89:1397-405.
9. Department of Health and Human Services, Office of Disease Prevention and Health Promotion (US). *Healthy People 2010*. *Nasnewsletters* 2000;15:3.
10. Delpierre C, Dray-Spira R, Cuzin L, Marchou B, Massip P, Lang T, et al. Correlates of late HIV diagnosis: implications for testing policy. *Int J STD AIDS* 2007;18:312-7.
11. Jean-Jacques M, Walensky RP, Aaronson WH, Chang Y, Freedberg KA. Late diagnosis of HIV infection at two academic medical centers: 1994–2004. *AIDS Care* 2008;20:977-83.
12. Late HIV testing—34 states, 1996–2005. *MMWR Morb Mortal Wkly Rep* 2009;58(24):661-5.
13. Centers for Disease Control and Prevention (US). Cases of HIV infection and AIDS in the United States and dependent areas, 2007. *HIV/AIDS Surveillance Report Vol. 19*. Atlanta: CDC; 2009.
14. Longo B, Pezzotti P, Boros S, Urciuoli R, Rezza G. Increasing proportion of late testers among AIDS cases in Italy, 1996–2002. *AIDS Care* 2005;17:834-41.
15. Brookmeyer R. Reconstruction and future trends of the AIDS epidemic in the United States. *Science* 1991;253:37-42.
16. Schwarcz S, Hsu L, Dilley JW, Loeb L, Nelson K, Boyd S. Late diagnosis of HIV infection: trends, prevalence, and characteristics of people whose HIV diagnosis occurred within 12 months of developing AIDS. *J Acquir Immune Defic Syndr* 2006;43:491-4.
17. Department of Health and Human Services (US), Panel on Antiretroviral Guidelines for Adults and Adolescents. Guidelines for the use of antiretroviral agents in HIV-1-infected adults and adolescents. 2011 [cited 2011 Feb 28]. Available from: URL: <http://www.aidsinfo.nih.gov/ContentFiles/AdultandAdolescentGL.pdf>
18. CDC (US). Diagnoses of HIV infection and AIDS in the United States and dependent areas, 2008. *HIV Surveillance Report Vol. 20*. Atlanta: CDC; 2010.
19. CDC (US). US HIV and AIDS cases reported through June 2001. *HIV/AIDS Surveillance Report Vol. 13*, No. 1. Atlanta: CDC; 2003.
20. CDC (US). Cases of HIV infection and AIDS in the United States, 2002. *HIV/AIDS Surveillance Report Vol. 14*. Atlanta: CDC; 2004.
21. CDC (US). Cases of HIV infection and AIDS in the United States, 2003. *HIV/AIDS Surveillance Report Vol. 15*. Atlanta: CDC; 2004.
22. CDC (US). Cases of HIV infection and AIDS in the United States, 2004. *HIV/AIDS Surveillance Report Vol. 16*. Atlanta: CDC; 2005.
23. CDC (US). Cases of HIV infection and AIDS in the United States and dependent areas, 2005. *HIV/AIDS Surveillance Report Vol. 17*. Atlanta: CDC; 2007.

24. CDC (US). Cases of HIV infection and AIDS in the United States and dependent areas, 2006. HIV/AIDS Surveillance Report Vol. 18. Atlanta: CDC; 2008.
25. Potard V, Weiss L, Lamontagne F, Rouveix E, Beck-Wirth G, Drogoul-Vey MP, et al. Trends in post-infection CD4 cell counts and plasma HIV-1 RNA levels in HIV-1-infected patients in France between 1997 and 2005. *J Acquir Immune Defic Syndr* 2009;52:422-6.
26. Weiss PJ, Brodine SK, Goforth RR, Kennedy CA, Wallace MR, Olson PE, et al. Initial low CD4 lymphocyte counts in recent human immunodeficiency virus infection and lack of association with identified coinfections. *J Infect Dis* 1992;166:1149-53.
27. Weiss PJ, Wallace MR. Rethinking CD4+ T cell counts for individuals who recently seroconverted to human immunodeficiency virus. *Clin Infect Dis* 1995;21:666-8.
28. Miles MB. *Qualitative data analysis: an expanded sourcebook*. 2nd ed. Thousand Oaks (CA): Sage Publications, Inc.; 1994.
29. Hall HI, Song R, Rhodes P, Prejean J, An Q, Lee LM, et al. Estimation of HIV incidence in the United States. *JAMA* 2008;300:520-9.
30. Lee LM, McKenna MT. Monitoring the incidence of HIV infection in the United States. *Public Health Rep* 2007;122 Suppl 1:72-9.
31. San Francisco Department of Public Health. HIV/AIDS epidemiology annual report, 2007. San Francisco: San Francisco Department of Public Health AIDS Office; 2008.
32. Klein D, Hurley LB, Merrill D, Quesenberry CP Jr. Review of medical encounters in the 5 years before a diagnosis of HIV-1 infection: implications for early detection. *J Acquir Immune Defic Syndr* 2003;32:143-52.