Counseling and Testing for HIV Prevention: Costs, Effects, and Cost-Effectiveness of More Rapid Screening Tests

Paul G. Farnham, PhD
Robin D. Gorsky, PhD
David R. Holtgrave, PhD
Wanda K. Jones, DrPH
Mary E. Guinan, MD PhD

Dr. Farnham, Dr. Holtgrave, and Dr. Guinan are with the Division of HIV/AIDS Prevention, National Center for HIV, STD, and TB Prevention,* Centers for Disease Control and Prevention (CDC), Atlanta. Dr. Farnham is also with the Department of Economics, Georgia State University, Atlanta. Dr. Holtgrave is also with the Center for AIDS Intervention Research, Medical College of Wisconsin, Milwaukee. Dr. Gorsky (deceased) was with the Division of HIV/AIDS Prevention (CDC) and the Department of Health Management and Policy, University of New Hampshire, Durham. Dr. Jones is with the Office of Women's Health, Office of the Director, CDC.

*Name of Center pending approval.

Tearsheet requests to Paul G. Farnham, PhD, Department of Economics, Georgia State University, Atlanta, GA 30303; tel. 404-651-2624; fax 404-651-3996; e-mail <ecopgf@langate.gsu.edu>.

SYNOPSIS

NEW RAPID HUMAN immunodeficiency virus (HIV) antibody tests permit many individuals to receive test results and appropriate counseling at one clinic visit. Because currently used tests require significant time for processing, all individuals must return for a second visit for test results and counseling. Since return rates for the second visit are low, the more rapid tests present an opportunity to improve the efficiency of HIV counseling and testing.

The authors compared the costs and effectiveness of the currently used counseling and testing procedure and a streamlined procedure made possible by the new, more rapid screening tests. When test-positive clients are given preliminary screening test results, the rapid procedure is more cost-effective than the current procedure. Since over 90% of the clients in most clinics will test negative, the rapid counseling and testing procedure allows the vast majority of clients to be counseled and tested and to receive their results and posttest counseling in one visit. However, in the case where the goal of HIV counseling and testing is to focus only on infected individuals, if information regarding a positive result from the rapid screening test is not given to clients at the initial visit before a confirmatory test is performed, then the rapid counseling and testing procedure is not more cost-effective than the current procedure.

Counseling and testing (C/T) for human immunodeficiency virus antibodies has been a major component of U.S. HIV prevention and care strategies. In 1991, more than two million HIV antibody tests were performed at publicly funded sites, of which approximately 58,000 (2.8%) were positive. Nearly two-thirds both of reported tests and positive test results occurred at freestanding HIV-C/T sites and sexually transmitted disease (STD) clinics[1].

At least two complex public policy questions concerning HIV C/T have evolved: When and what types of test information and counseling should clients receive? and should the purpose of HIV C/T be to focus only on HIV-infected individuals for prevention and health care services or to inform and counsel both infected and uninfected individuals about the implications of their test results?

Under the current procedures, HIV counseling and testing includes the following steps (Table 1): Step 1. The client is offered counseling and testing. Step

Table 1. Components of counseling and testing (C/T) procedures

Component	Current C/T		Rapid C/T	
	HIV-	HIV+	HIV-	HIV+
1. Administrative processing/offer of C/T	X	X	X	X
2. Pretest counseling	X	X	X	X
3. Draw blood	X	X	X	X
4. Transport to laboratory	X	X	X	X
5. Screening and confirmatory testing:				
Initial ELISA test	X	X	...	...
Followup ELISA tests, n=2	...	X	...	...
Initial rapid test	...	...	X	X
Followup rapid test, n=1	...	...	...	X
Western blot test	...	X	...	X
6. Test results/posttest counseling:				
Waiting time—initial visit	...	...	X	X
Posttest counseling, initial visit	...	...	X	X
Time for return	X	X	...	X
Administrative processing, return visit	X	X	...	X
Posttest counseling, return visit	X	X	...	X

2. Clients who accept are counseled prior to testing (pretest counseling). Step 3. A blood sample is drawn from the client. Step 4. The sample is transported to a laboratory, which may be either on- or off-site. Step 5. The serum is tested for HIV antibody using a screening test. If this result is negative, there is no further testing. If the test is positive, screening tests are repeated using the same specimen. Positive results on the repeated screening tests require a follow-up confirmatory test. Step 6. Test results are given to the clinician/counselor, who informs and counsels the client (posttest counseling).

Recently developed rapid HIV-antibody screening tests allow changes in Steps 4 through 6, eliminating time lags. The current counseling and testing procedure generally relies on the enzyme-linked immunosorbent assay (ELISA), designed for batch testing, as the initial screening test[2]. The average time for accumulating and running an ELISA batch is two to three hours. Low-volume laboratories may transport specimens to a higher volume laboratory to reach the optimum batch size, further increasing the time from Step 4 to Step 5. The most widely used confirmatory test, the Western blot, may not be performed every day in most laboratories. Therefore, under the current procedure, test results are not available during the client's first visit, thus requiring a return visit one to three weeks later to learn test results and receive posttest counseling.

Alternatively, the rapid HIV screening tests are designed to be used as a single assay and take 10 minutes or less on average[2]. With rapid tests, even a low-volume on-site laboratory can provide test results at the client's first visit. However, as in the current C/T procedure, the confirmatory Western blot test is used for specimens that screen positive, thus requiring a return visit for these individuals.

With rapid tests, even a low-volume on-site laboratory can provide test results at the client's first visit.

Under the current C/T procedure, many clients do not return for their test results and posttest counseling[3]. In 1990, only 64% of clients at publicly funded sites returned for test results and posttest counseling[4]. Return rates varied substantially by type of service delivery site: 42% at STD clinics, 54% at family planning clinics, and 58% at prenatal and obstetric testing sites.

Tested clients who do not return for test results and posttest counseling do not receive the full benefit of this HIV prevention strategy. Posttest counseling provides the opportunity to discuss with clients risk behavior and ways of reducing risk, to refer at-risk clients to prevention services, and to refer infected individuals for medical and social services[4,5].

Two alternative strategies would increase the proportion of clients who receive the complete intervention: *(a)* increase return rates under the current C/T procedure or *(b)* eliminate the need for a return visit for most clients by using the rapid HIV screening test. The choice of strategies is influenced by the costs and effectiveness of each approach. Cost-effectiveness estimates will vary depending on whether the test site emphasizes the provision of the intervention to all individuals or only to HIV-infected persons.

We present a cost-effectiveness analysis based on a decision model comparing a streamlined C/T procedure using

the rapid HIV screening test with the current C/T procedure. We develop disaggregated estimates of the societal costs of each testing procedure and employ two alternative outcome measures reflecting possible differences in the goals of the C/T process.

Methods

We developed a decision model that was based on a societal perspective and included all costs and effects incurred by both providers and clients. We incorporated cost estimates drawn from the counseling and testing literature and expert opinion and imputed values for variables such as client travel and waiting time. Our model's parameters were based on cost figures for publicly funded clinics.

We also looked at two variations from our basic model. Variation One incorporated only the explicit costs to the providers and excluded valuations of client time. For variation Two, we assigned an alternate outcome value to cases of clients who test positive with the rapid test and do not return for a confirmatory visit to analyze the implications of providing information based on the rapid screening test alone.

Our analysis was developed from the perspective of adding one or the other testing procedure to an existing clinic or provider not presently offering HIV C/T. We assumed that a client would not have been counseled or tested in the absence of these procedures. Incremental cost-effectiveness ratios were calculated using SMLTREE, version 2.99.

Outcome Measures. We measured two different outcomes: *(a)* the number of HIV-infected individuals who correctly learn their serostatus and *(b)* the number of infected and uninfected individuals who correctly learn their serostatus. Both outcomes are important but may receive different emphasis depending on the clinical setting. Different counseling approaches are used for infected and uninfected individuals[5]. Budgetary constraints and beliefs about the effectiveness of counseling for each group often determine a clinic's emphasis.

We counted the number of individuals (HIV-infected only or both infected and uninfected) who would correctly learn their serostatus under each testing procedure, assigning each a value of one. We assigned a zero value to individuals who fail to return to receive their test information or who receive incorrect information (false positive or false negative tests).

Diagnosis of HIV infection under the current C/T procedure is based primarily on the Western blot (WB) confirmatory test, which is done only if the ELISA is positive[2]. An initially reactive ELISA test is followed by two subsequent ELISA tests and the WB test to minimize the chance of a diagnostic error. Therefore, under the current C/T procedure, individuals must return in one to three weeks to learn test results.

With the rapid C/T procedure, a key issue is what information and counseling will be provided to test-positive clients at the first visit[6,7]. We assumed that all individuals will receive test results at the first visit and that test-negative individuals will be told they are uninfected and counseled to help them maintain that status. We also assumed that individuals who test positive will be told they are "likely infected," counseled appropriately, and asked to return for the confirmatory WB results. In an evaluation of rapid test procedures, Kassler et al[8]. found this approach to be acceptable to both counselors and clients. Phrases such as "likely infected," "good chance of being infected," and "usually infected" were used to communicate the probability of infection.

With the rapid C/T procedure, a key issue is what information and counseling will be provided to test-positive clients at the first visit.

Figure 1. HIV counseling and testing: current CT procedure

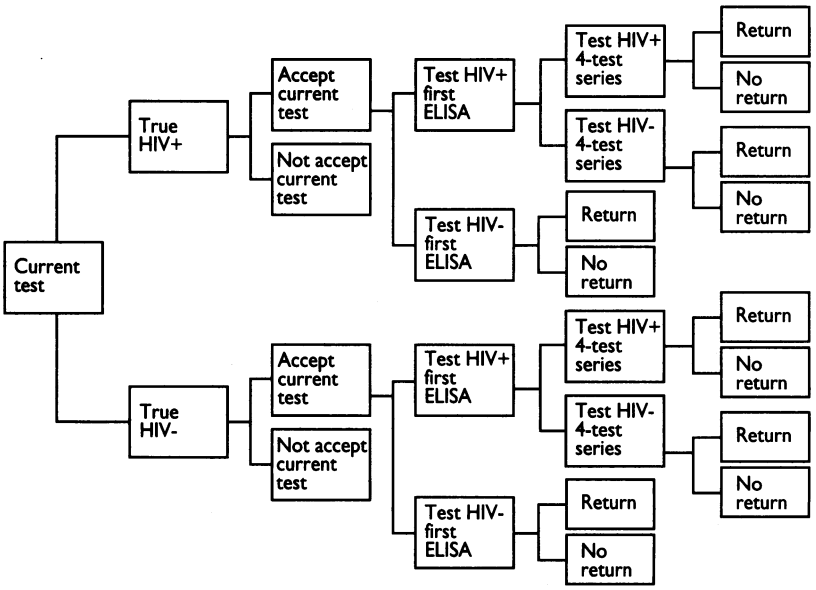
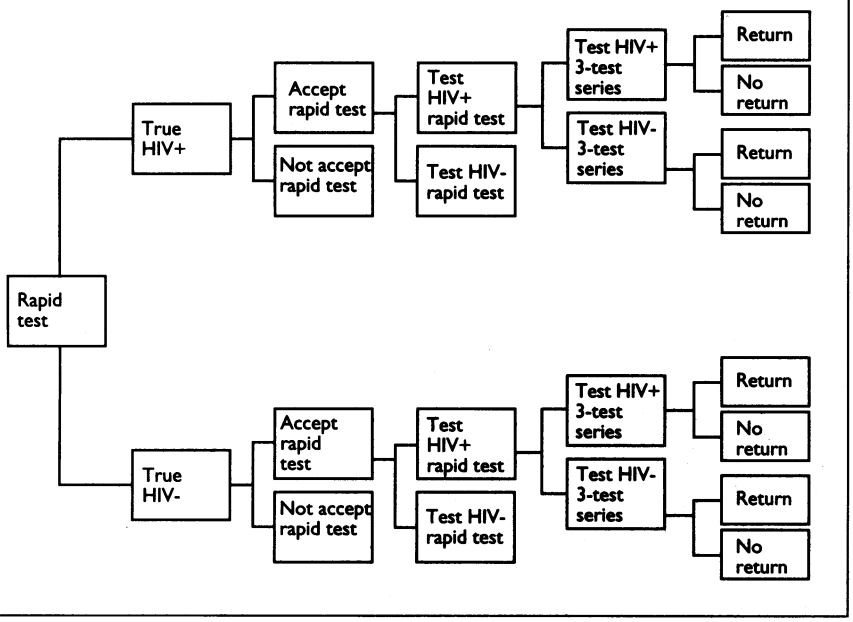


Figure 2. HIV counseling and testing: rapid CT procedure



Important policy issues arise from the type of counseling these "likely infected" individuals receive at the initial visit and the value placed on this information. Since some "likely infected" individuals will not return for the confirmatory WB results, the information they receive at the first visit is critical. For our model, we valued information and counseling provided at the first visit for infected individuals who do not return for confirmatory results as almost equivalent to receiving the confirmatory information and assigned such individuals a value of 0.99. Because this assumption may be controversial, we performed a sensitivity analysis on the outcome value. The outcomes for all uninfected individuals who are told they are "likely infected" were assigned zero values since incorrect information was provided.

Model Probabilities. The decision model underlying our cost-effectiveness analysis is shown in Figure 1 for the current C/T procedure and Figure 2 for the rapid C/T procedure. Model probabilities and data sources are presented in Table 2.

We assumed that the proportion of HIV-infected individuals in the population tested under each procedure was 0.04 (first chance node)[9]. The second chance node was the probability of an individual accepting pretest counseling which may depend upon an individual's serostatus as well as the type of test procedure[10,11]. We assumed in the basic analysis that all individuals agree to be tested regardless of serostatus or type of test.

The accuracy of the HIV antibody test and test algorithm was the next factor. Under the current test procedure (three ELISAs and one WB performed on the same specimen), there is a four-test algorithm with (++++) or (+-++) or (++-+) indicating positive results[12]. We assumed a three-test algorithm under the rapid C/T procedure (two rapid tests and one WB on the same specimen), with (+++) or (+-+) indicating positive results. All other combinations were considered negative results.

No consensus exists on a standard algorithm for the rapid test. With the current C/T procedure, initially reactive ELISAs are repeated twice to minimize the possibility of random error in batch processing. In the rapid test algorithm, where specimens can be run singly or in batch, the likelihood of random error introduced by splashing or specimen mix-up is reduced.

We assumed the sensitivity and specificity of the initial ELISA test to be 0.998[2]. Negative results on the first ELISA test receive no further attention. Blood samples that are reactive under the initial ELISA test undergo the four-test sequence. Based on calculations from George and Schochetman[2], which are available from the corresponding author, the probability of a false negative is 0.00025 and the probability of a false positive is 0.000000772 after the four-test algorithm, given

Table 2. Decision model probabilities

Variable	Value	Reference
Current C/T procedure:		
HIV seroprevalence	0.04	9
HIV-infected client accepts current test	1.00	[1]
Uninfected client accepts current test	1.00	[1]
Test HIV+, given HIV+, 1st ELISA	0.998	2
Test HIV+, given HIV-, 1st ELISA	0.002	2
Test HIV+, given HIV+, 4-test series	1.00	[2]
Test HIV+, given HIV-, 4-test series	0.00	[2]
HIV-infected client returns for results	0.60	[1],4,13
Uninfected client returns for results	0.40	[1],4,13
Rapid C/T procedure:		
HIV seroprevalence	0.04	9
HIV-infected client accepts rapid test	1.00	[1]
Uninfected client accepts rapid test	1.00	[1]
Test likely HIV+, given HIV+, rapid test	0.993	2
Test likely HIV+, given HIV-, rapid test	0.005	2
Test HIV+, given HIV+, 3-test series	1.00	[2]
Test HIV+, given HIV-, 3-test series	0.00	[2]
HIV-infected client returns for results	0.80	[1]
Uninfected client (who tests positive) returns for results	0.80	[1]

[1]Baseline assumption.
[2]Calculated from 2.

a 0.04 proportion of HIV-infected individuals in the population. Thus, the four-test sequence is a perfect test for all practical purposes.

We assumed the sensitivity of the initial rapid test to be 0.993 and the specificity, 0.995[2]. The three-test algorithm makes the rapid test sequence essentially a perfect test given a proportion of HIV-infected individuals of 0.04. For the three-test algorithm, the probability of a false negative is 0.000457 and the probability of a false positive is 0.000485.

The seronegative window period between the time of HIV acquisition and seroconversion would not differ between the current and rapid C/T procedures and was not considered in this analysis. Clients with high-risk behavior who test negative would be counseled about the need for both behavior change and future testing[5].

The final chance node for both the current and rapid C/T procedures is the probability of a client returning for the test result. All individuals are asked to return under the current C/T procedure, while only those who test positive with the rapid screening test are asked to return for confirmatory results under the rapid C/T procedure. The probability of returning for posttest counseling varies depending on many factors including an individual's expected HIV serostatus, risk exposure category or demographics, the type of delivery site, and the reason for an initial visit[4]. In a 1990 study of publicly funded C/T sites, 82% of infected individuals and 63% of uninfected individuals returned for posttest counseling[4]. Results from the 1990 National Health Interview Survey indicate that 53% of those at increased risk who had a voluntary HIV-antibody test received posttest counseling in contrast to 28% of those not at increased risk[13]. For this model, we assumed that 60% of infected individuals return to obtain their test results under the current procedure while 40% of those not infected return. The comparable figures for those who are asked to return under the rapid C/T procedure are assumed to be 80% for both infected and uninfected (but diagnosed "likely positive") individuals.

The total cost under the current HIV C/T procedure was $103 for an infected individual and $33 for an uninfected individual, each of whom was correctly informed of his/her serostatus and received posttest counseling.

Input Costs. Table 3 shows the input costs incorporated into the model and their sources for both procedures. Since the costs were measured from the perspective of adding HIV counseling and testing services to an existing health care facility, only the incremental costs were considered. None of the fixed costs of the facility were included. All cost variables were subdivided into price and quantity components so the effect of each of these variables could be judged independently. The value of clients' time—for counseling and testing sessions and for return visits—was imputed by using data on the median earnings of all workers[14]. Costs were measured in 1992 dollars[14,15].

We calculated costs for HIV-infected and uninfected individuals under both test sequences. For an HIV-infected individual under the current C/T procedure, the figure for the first visit included administrative costs, the cost of pretest counseling, and the costs of three ELISA tests and a Western blot test. The cost figure for the return visit was based on the client's time, administrative costs, and the cost of posttest counseling. An uninfected individual incurs the same administrative and pretest counseling costs on the initial visit but only one ELISA test. He or she also receives shorter posttest counseling on the return visit.

With the rapid C/T procedure, the cost figure for an uninfected individual reflected administrative and pretest counseling costs on the first visit, the cost of the rapid test, the cost to the client of waiting time at the clinic, and the cost of posttest counseling at that visit. For the individual who screened positive, the total figure included the same administrative and pretest counseling costs, the costs of two rapid tests, a longer waiting time, a more extensive posttest counseling session at that visit, and a confirmatory WB. The costs for the return visit for this "likely infected" individual were assumed to be the same as for the infected individual under the current C/T procedure, whether or not the WB is reactive. With the rapid C/T procedure, all of these individuals would have been told they were "likely infected" at the initial session and would require the longer posttest counseling at the return visit.

Since we disaggregated our costs into price and quantity variables and imputed values for client waiting and travel time, our overall cost measures are not directly comparable to many of the estimates in the literature[16-28]. However, our calculated results for specific tests (Table 3) are similar to those in the literature[16,20,23,25,29]. Only a few studies of the costs of HIV prevention interventions have incorporated original data collection based on provider surveys and time diaries[28,29]. Therefore, all cost variables in our models were subject to sensitivity analysis.

Variations of the Basic Analysis. The basic analysis of the decision model incorporated all costs measured from the

societal perspective. Variation One was the basic analysis excluding valuation of client time. Variation Two was the basic analysis with the exception that we valued the outcome for the HIV-infected individual who tests positive under the rapid test but does not return for confirmatory results at zero rather than 0.99.

Results

The total cost under the current HIV C/T procedure was $103 for an infected individual and $33 for an uninfected individual, each of whom was correctly informed of his/her serostatus and received posttest counseling (Table 3). For the rapid C/T procedure, the total cost for correct information and counseling was $135 for an infected individual and $33 for an uninfected individual. In both cases, the costs are lower for uninfected clients due to fewer tests and shorter counseling sessions. In addition, the rapid C/T procedure eliminates the need for return visits for uninfected individuals, further reducing costs.

For the cost-effectiveness analysis, we adjusted these cost figures for the fact that not all individuals will agree to be tested or will return for test results. The adjusted or "expected cost" was derived by multiplying the cost figure based on full participation (as presented above) by the probabilities of an individual completing the various steps of the

Table 3. Decision model cost variables

	Current procedure				Rapid procedure			
	Positive		Negative		Positive		Negative	
Variable	Value	Reference	Value	Reference	Value	Reference	Value	Reference
Total cost	$103	[1]	$33	[1]	$135	[1]	$33	[1]
Counseling, testing, first visit	72	[1]	20	[1]	104	[1]	...	...
Wage rate, administrative processing (per hour)	8	14	8	14	8	14	8	14
Time, administrative processing (fraction of hour)	0.25	[2]	0.25	[2]	0.25	[2]	0.25	[2]
Wage rate, counselor, pretest (per hour)	$14	14	14	14	14	14	14	14
Time, pretest counseling (fraction of hour)	0.50	28,29	0.50	28,29	0.50	28,29	0.50	28,29
Value of client time, pretest (per hour)	$10	14	10	14	10	14	10	14
Value of client time, waiting (per hour)	...	...	...	...	...	...	10	14
Time, waiting (fraction of hour)	...	...	...	...	1.50	[2]	0.75	[2]
Wage rate, administrative, laboratory work, ELISA or Rapid test (per hour)	$15	14,15	15	14,15	15	14,15	15	14,15
Time, administrative, laboratory work, ELISA or Rapid test (fraction of hour)	0.33	[2]	0.33	[2]	0.10	[2]	0.10	[2]
Cost of materials, ELISA or Rapid test	$1	29	1	29	4	2,[2]	4	2,[2]
Wage rate, counselor, posttest (per hour)	...	...	...	...	14	14	14	14
Time, posttest counseling (fraction of hour)	...	...	...	...	1	[2]	0.25	[2]
Value of client time, posttest (per hour)	...	...	...	...	10	14	10	14
Wage rate, administrative, laboratory work, Western blot (per hour)	15	14,15	...	...	15	14,15	...	...
Time, administrative, laboratory work, Western blot (per hour)	1	[2]	...	...	1	[2]	...	...
Cost of materials, Western blot	25	16,20,23,29	...	...	25	16,20,23,29	...	...
Cost of counseling, return visit	31	[1]	13	[1]	31	[1]	...	...
Value of client time, return (per hour)	10	14	10	14	10	14	...	...
Time, client return (fraction of hour)	0.50	[2]	0.50	[2]	0.50	[2]	...	...
Wage rate, administrative processing (per hour)	$8	14	8	14	8	14	...	...
Time, administrative processing (fraction of hour)	0.25	[2]	0.25	[2]	0.25	[2]	...	...
Wage rate, counselor, posttest (per hour)	$14	14	14	14	14	14	...	...
Time, posttest counseling (per hour)	1	5,29	0.25	5,29	1	[2]	...	...
Value of client time, posttest (per hour)	10	14	10	14	10	14	...	...

[1]Calculated value.

[2]Baseline assumption.

process. To derive cost-effectiveness ratios, these expected costs were divided by the expected effects, i.e., the number of individuals receiving correct test results and counseling. The latter is also affected by the probabilities of an individual completing the various steps of the process.

Cost-effectiveness results for the basic analysis are presented in Table 4 for Outcome I, for which we included only HIV-infected individuals who correctly learn their serostatus, and Outcome II, for which we counted correctly informed infected and uninfected individuals. The cost-effectiveness ratios are incremental ratios comparing each C/T procedure with a no-testing situation.

For Outcome I, the expected costs were $28 for the current C/T procedure and $37 for the rapid C/T procedure. The expected effect was 0.024 clients for the current procedure and 0.040 for the rapid procedure. Dividing the expected cost by the expected effect, we obtained a cost-effectiveness ratio for the current procedure of $1165 per HIV-infected client correctly counseled and tested and a ratio of $940 for the rapid procedure. Thus, the cost per HIV-infected client correctly counseled and tested was less for the rapid procedure than for the current procedure. For Outcome II, the expected costs were the same, but the expected effects were 0.408 for the current procedure and 0.999 for rapid procedure. The cost-effectiveness ratios ($68 versus $37 per client informed, regardless of serostatus) again favored the rapid C/T procedure.

Variation One, which included provider costs only, gave an expected cost of $20 for the current C/T procedure and $21 for the rapid C/T procedure. Since the effects were the same as in the basic analysis, the cost-effectiveness ratios favored the rapid C/T procedure ($821 versus $531 for Outcome I; $48 versus $21 for Outcome II).

In Variation Two, for which we assigned a value of zero to infected individuals who are told they are "likely infected" after the rapid screening test but who do not return for confirmatory test results, the cost-effectiveness ratios favored the current C/T procedure for Outcome I, which counted only the HIV-infected ($1165 for the current procedure versus $1172 for the rapid procedure). The ratios favored the rapid procedure for Outcome II.

For the basic analysis, we performed sensitivity analyses on all variables except the proportion of HIV-infected individuals and those measuring the accuracy of the tests. Table 5 presents the variables that caused the cost-effectiveness ratio of the rapid C/T procedure to equal that of the current C/T procedure (breakeven). The table compares the basic analysis values of these variables with the break-even values. The cost-effectiveness ratios were most sensitive to client return rates and pre- and posttest counseling times.

With the given sensitivity and specificity of the tests, the results regarding the accuracy of the four- and three-test algorithms hold for proportions of HIV-infected individuals ranging from 0.01 to 0.10.

Table 4. Decision model results

Model	*Costs*	*Effects*	*Costs-effects*
	Basic analysis[1]		
Outcome I (HIV-infected only):			
Current C/T procedure	$27.91	0.0240	$1,165.26
Rapid C/T procedure	37.27	0.0396	940.07
Outcome II (HIV-infected and uninfected):			
Current C/T procedure	27.91	0.4080	68.42
Rapid C/T procedure	37.27	0.9987	37.31
	Variation one[2]		
Outcome I (HIV-infected only):			
Current C/T procedure	19.67	0.0240	821.25
Rapid C/T procedure	21.06	0.0396	531.35
Outcome II (HIV-infected and uninfected):			
Current C/T procedure	19.67	0.4080	48.22
Rapid C/T procedure.	21.06	0.9987	21.09
	Variation two[3]		
Outcome I (HIV-infected only):			
Current C/T procedure	27.91	0.0240	$1,165.26
Rapid C/T procedure	37.27	0.0318	1,172.74
Outcome II (HIV-infected and uninfected):			
Current C/T procedure	27.91	0.4080	68.42
Rapid C/T procedure	37.27	0.9908	37.61

[1]Societal costs; Outcome value of 0.99 for an infected, "likely-positive," non-returning, rapid C/T client.

[2]Provider costs; Outcome value of 0.99 for an infected, "likely-positive," non-returning, rapid C/T client.

[3]Societal costs; Outcome value of 0.00 for an infected, "likely-positive," non-returning, rapid C/T client.

Discussion

Policy Issues. Our analysis shows that the rapid HIV counseling and testing procedure is generally a more cost-effective alternative to the current procedure for publicly funded clinics, whether costs are measured from the societal or provider perspective. This result is particularly robust if the goal of the HIV counseling and testing process is to have both infected and uninfected individuals correctly learn their serostatus (Outcome II). If the goal is to target HIV-infected individuals (Outcome I), the rapid C/T procedure is more cost-effective, only when the information received by infected individuals from the rapid test alone is seen as almost as valuable as that provided through Western blot confirmation.

This latter result raises an important policy issue. Under the current C/T procedure, no information is provided to a client at the first visit based on the ELISA screening test alone. We assumed that for the rapid C/T procedure all individuals who test negative will be told they are uninfected at the first visit. This is a major factor influencing the cost-effectiveness of the rapid procedure. Many of these individuals might not have returned for their test results under the current C/T procedure and would, therefore, not have received this information.

Table 5. Sensitivity analysis: basic analysis

Variable	Basic value	Break-even value	Percent change from basic value
	Outcome I (HIV-infected only)		
Model probabilities:			
HIV+ client returns for results, current test	0.60	0.75	+ 25
HIV- client accepts current test	1.00	0.50	- 50
HIV+ client accepts rapid test	1.00	0.78	- 22
Current C/T procedure:			
Wage rate, counselor, pretest (hourly)	$14.00	$3.20	- 77
Time, pretest counseling (fraction of hour)	0.50	0.27	- 46
Rapid C/T procedure:			
Wage rate, administrative processing (hourly)	$8.00	$43.70	+ 446
Time, administrative processing (fraction of hour)	0.25	1.40	+ 460
Wage rate, counselor, pretest (hourly)	$14.00	$31.90	+ 128
Time, pretest counseling (fraction of hour)	0.50	0.88	+ 76
Value of client time, pretest (hourly)	$10.00	$ 27.90	+ 179
Wage rate, administrative, laboratory work, rapid test (hourly)	$15.00	$100.40	+ 569
Time, administrative, laboratory work, rapid test (fraction of hour)	0.10	0.67	+ 570
Cost of materials, rapid test	$4.00	$12.60	+ 215
Value of client time, waiting time (hourly)	$10.00	$21.40	+ 114
Time, waiting for results, HIV- client (fraction of hour)	0.75	1.69	+ 125
Wage rate, counselor, posttest (hourly)	$14.00	$45.50	+ 225
Time, posttest counseling, HIV- client, first visit (fraction of hour)	0.25	0.64	+ 156
Value of client time, posttest (hourly)	$10.00	$41.50	+ 315
Time, waiting for results, likely HIV+ client (fraction of hour)	1.50	21.60	+ 1,340
Time, posttest counseling, HIV+ client, first visit (fraction of hour)	1.00	9.40	+ 840

Variable	Basic value	Break-even value	Percent change from basic value
	Outcome II (HIV-infected and uninfected)		
Model probabilities:			
HIV- client returns for results, current test	0.40	0.95	+ 138
HIV- client accepts rapid test	1.00	0.34	- 66
Rapid C/T procedure:			
Wage rate, administrative processing (hourly)	$8.00	$132.20	+ 1,553
Time, administrative processing (fraction of hour)	0.25	4.20	+ 1,580
Wage rate, counselor, pretest (hourly)	$14.00	$76.10	+ 444
Time, pretest counseling (fraction of hour)	0.50	1.80	+ 260
Value of client time, pretest (hourly)	$10.00	$ 72.10	+ 621
Wage rate, administrative, laboratory work, rapid test (hourly)	$15.00	$312.40	+ 1,983
Time, administrative, laboratory work, rapid test (fraction of hour)	0.10	2.09	+ 1,990
Cost of materials, rapid test	$4.00	$33.80	+ 745
Value of client time, waiting time (hourly)	$10.00.	$49.70	+ 397
Time waiting for results, HIV- client (fraction of hour)	0.75	4.00	+ 433
Wage rate, counselor, posttest counseling (hourly)	$14.00	$123.60	+ 783
Time, posttest counseling, HIV-client, first visit (hourly)	$0.25	$1.60	+ 540
Value of client time, posttest counseling (hourly)	$10.00	$119.60	+ 1,096
Time, waiting for results, likely HIV+ client (fraction of hour)	1.50	71.30	+ 4,653
Time, posttest counseling, likely HIV+ client (fraction of hour)	1.00	0.10	+ 2,910

We also assumed that individuals who test positive with the rapid test will be given this information at the initial visit and asked to return for the results of the confirmatory WB test. If decision makers believe that the information from the rapid screening test should not be given to clients because of concerns over possible false positives and that counseling and testing should be targeted to infected individuals only, there is no advantage from a cost-effectiveness perspective of using the rapid test. An ELISA screening test would be equally cost-effective if no test results are given out until the return visit.

Sensitivity Analysis: Outcome I. The sensitivity analysis indicates several parameter changes that could increase the cost- effectiveness of the current C/T procedure (Table 5). Other factors constant, an increase in the return rate of 25% for HIV-infected individuals under the current C/T procedure or a decrease in the number of uninfected individuals who are tested by 50% would make the current C/T procedure appear more cost-effective if the policy focus is on only HIV-infected individuals (Outcome I). However, if additional outreach costs are incurred to increase the return rate, this favorable effect would be diminished.

If the pretest counseling time is only one-quarter hour under the current C/T procedure, which may have a negative effect on client return rates[4], the current C/T procedure would be as cost-effective as the rapid procedure. A short pretest counseling session may lower return rates since individuals may not have the time to personalize the risk of HIV infection and may thus feel less compelled to return and learn their test results[4].

Only one other current C/T procedure variable, the pretest counselor's wage rate, can be varied sufficiently to make the two tests equivalent with respect to the cost-effectiveness ratios for Outcome I. This variable would have to decrease by 77%, all else constant, to reach the break-even cost-effectiveness ratio.

For the rapid C/T procedure, an increase in pretest counseling time from 0.5 to 0.88 hours, all else constant, would increase the expected cost sufficiently to breakeven with the current procedure. An increase in either posttest counseling time for uninfected individuals from 0.25 to 0.64 hours or in waiting time at the initial session for these individuals from 0.75 to 1.69 hours would also make the cost-effectiveness ratio of the rapid procedure equal to that of the current procedure under Outcome I.

Sensitivity Analysis: Outcome II. If the goal of HIV counseling and testing is to have both HIV-infected and uninfected individuals correctly learn their serostatus, the return rate of uninfected individuals has the greatest impact on the evaluation of the two procedures. An increase in the probability of an uninfected individual returning for test results from 0.40 to 0.95 under the current C/T procedure or a decrease in the likelihood of an uninfected individual accepting the rapid C/T procedure from 1.00 to 0.34, all else held constant, would make the two cost-effectiveness ratios equal. The rapid C/T procedure is generally more cost-effective since uninfected individuals who would not return to learn their test results under the current C/T procedure are more likely to receive information on their initial visit under the rapid C/T procedure.

We found that *no* changes in the cost parameters for the current C/T procedure could decrease the costs sufficiently to make the cost-effectiveness ratio for the current C/T procedure equal to that for the rapid C/T procedure when the number of correctly informed HIV-infected and uninfected individuals is the outcome measure.

The sensitivity analysis results for the rapid C/T procedure variables are extremely robust. Increases in the values of these variables by 260% to over 4600% would be needed to make the cost-effectiveness ratio of the rapid C/T procedure equal to that for the current C/T procedure (Table 5). Changes in the quantity variables also have much less impact under Outcome II than under Outcome I. Pretest counseling time would have to increase from 0.5 to 1.8 hours or waiting time at the initial visit for the uninfected individual would have to increase from 0.75 to 4.00 hours to reach the break-even point between the two testing procedures.

Limitations. Our study does not deal with confidentiality or other ethical issues surrounding HIV counseling and testing[30] or with measuring the quality of the counseling sessions[5]. Studies have shown that actual counseling sessions may deviate from CDC recommendations for effective counseling[3,5]. In addition, this study does not look at long-term impacts on behavior of HIV C/T, which should not differ under the two procedures examined here. The precise long-term effects of HIV counseling and testing appear to vary by population and warrant further study[9,31,32]. Such concerns must be weighed carefully in addition to the results of this analysis when choosing between the two testing procedures.

This study has been designed to compare each testing procedure to a no-testing situation. What are the considerations for a clinic already performing the current test? The incremental cost-effectiveness ratio of the rapid versus the current procedure is needed for that analysis. We calculated the ratio to be $596 for the basic analysis counting HIV-infected individuals only (Outcome I). The rapid test has both higher expected costs and greater expected output than the current test. Similar ratios can be calculated from Table 4.

This study was designed to be applicable to publicly funded clinics and test sites. Other research suggests that a large number of persons undergo HIV testing in private settings[5]. Although few studies have been done of private sector testing, there is evidence that clients are less likely to receive pre- and posttest counseling and that counseling may be of lower quality in these settings[5]. Thus, comparing the costs and effects of the current C/T procedure with the rapid C/T procedure in private settings remains an issue for future study.

Summary and Conclusions

How individuals obtain accurate knowledge of their HIV serostatus is an important policy issue, particularly given the problem of low return rates under the current C/T procedure. This issue will become even more complex with the development of new testing mechanisms such as home testing kits[30,33]. Our cost-effectiveness analysis of the current and rapid C/T procedures shows how different views of the value attached to information provided at various stages of the C/T process can affect the comparison of the procedures. Our results suggest a need for a re-examination of the current counseling and testing procedure as protocols are developed for the new tests entering the market.

This analysis has also emphasized that the choice between providing HIV counseling and testing for all individuals or for infected persons only can have an impact on the cost-effectiveness of the different procedures. We have shown how changes in the length of C/T sessions can affect cost-effectiveness ratios and may have an impact on other significant variables such as return rates. Decision makers must carefully weigh their own positions on these issues to make an informed choice among the available C/T options.

References

1. Centers for Disease Control and Prevention. Publicly funded HIV counseling and testing—United States, 1991. MMWR 1992; 41:613–617.
2. George JR, Schochetman G. Detection of HIV Infection Using Serologic Techniques. in AIDS Testing: A Comprehensive Guide to Technical, Medical, Social, Legal, and Management Issues, 2nd ed. G Schochetman and JR George, eds. New York: Springer-Verlag, 1994, 62–102.
3. Centers for Disease Control and Prevention. External Review of CDC's HIV Prevention Strategies by the CDC Advisory Committee on the Prevention of HIV Infection. Washington, DC: US Government Printing Office, 1994.
4. Valdiserri, RO, Moore M, Gerber AR, Campbell CH, Dillon BA, West GR. A study of clients returning for counseling after HIV testing: Implications for improving rates of return. Public Health Reports 1993;108:12–18.
5. Doll LS, Kennedy MB. HIV counseling and testing: What is it and how well does it work? in AIDS Testing. A Comprehensive Guide to Technical, Medical, Social, Legal, and Management Issues, 2nd ed. G Schochetman and JR George, eds. New York: Springer-Verlag, 1994, 302–319.
6. Squire SB, Elford J, Bor R, et al. Open access clinic providing HIV-I antibody results on day of testing: the first twelve months. British Medical Journal 1991;302: 1383–1386.
7. Morris DJ, Corbitt G, Crosdale E. Same-day testing for human immunodeficiency virus antibodies. Journal of Virological Methods 1994;49:367–370.
8. Kassler WJ, Dillon B, Haley C, et al. HIV prevention counseling using an on-site rapid HIV assay. In: Program and abstracts of the Tenth International Conference on AIDS, August 7–12, 1994; Yokohama, Japan. Abstract 518B/D.
9. Holtgrave DR, Valdiserri RO, Gerber AR, Hinman AR. Human immunodeficiency virus counseling, testing, referral, and partner notification services: A cost-benefit analysis. Archives of Internal Medicine 1993;153:1225–1230.
10. Hull HF, Bettinger CJ, Gallaher MM, Keller NM, Wilson J, Mertz GJ. Comparison of HIV-antibody prevalence in patients consenting to and declining HIV-antibody testing in an STD clinic. JAMA 1988;260:935–38.
11. Siegel K, Levine MP, Brooks C, Kern R. The motives for gay men for taking or not taking the HIV antibody test. Social Problems 1989;36:368–383.
12. Centers for Disease Control and Prevention. Interpretation and use of the western blot assay for serodiagnosis of human immunodeficiency virus type 1 infections. MMWR 1989;38(No. S-7:[inclusive page numbers].
13. Centers for Disease Control and Prevention. HIV counseling and testing services from public and private providers—United States, 1990. MMWR 1992;41:743–752.
14. U.S. Bureau of Labor Statistics. Employment and Earnings. Washington, DC: U.S. Government Printing Office, January, 1993.
15. Jahn M. A precarious balance on the shaky dollar. Medical Laboratory Observer 1993;25:24–29.
16. McCarthy BD, Wong JB, Munoz A, Sonnenberg FA. Who should be screened for HIV infection. A cost-effectiveness analysis. Arch Intern Med 1993;153:1107–1116.
17. Nahmias S, Feinstein CD. Screening strategies to inhibit the spread of AIDS. Socioecon Plann Sci 1990;24:249–260.
18. McKay NL, Phillips KM. An economic evaluation of mandatory premarital testing for HIV. Inquiry 1991;28:236–248.
19. Petersen LR, White CR, Premarital Screening Study Group. Premarital screening for antibodies to human immunodeficiency virus type 1 in the United States. Am J Public Health 1990;80:1087–1090.
20. Cleary PD, Barry MJ, Mayer KH, Brandt AM, Gostin L, Fineberg HV. Compulsory premarital screening for the human immunodeficiency virus. JAMA 1987;258:1757–1762.
21. Mockler RW, Kleiman MAR. With this test I thee wed: evaluating premarital AIDS testing. J Policy Analysis and Management 1988;7:557–562.
22. Turnock BJ, Kelly CJ. Mandatory premarital testing for human immunodeficiency virus: The Illinois experience. JAMA 1989;261:3415–3418.
23. Gelles GM. Costs and benefits of HIV-1 antibody testing of donated blood. J Policy Analysis and Management 1993;12: 512–531.
24. Eisenstaedt RS, Getzen TE. Screening blood donors for human immunodeficiency virus antibody: Cost-benefit analysis. Am J Public Health 1988;78:450–454.
25. Schwartz JS, Kinosian BP, Pierskalla WP, Lee H. Strategies for screening blood for human immunodeficiency virus antibody. JAMA 1990;264:1704–1710.
26. Bloom DE, Glied S. Benefits and costs of HIV testing. Science 1991;252:1798–1804.
27. Harris RL, Boisaubin EV, Salyer PD, Semands DF. Evaluation of a hospital admission HIV antibody voluntary screening program. Infect Control Hosp Epidemiol 1990;11:628–634.
28. Gorsky RD, MacGowan RJ, Swanson NM, DelGado BP. Prevention of HIV infection in drug abusers: A cost analysis. Preventive Medicine 1995;24:3–8.
29. Hedlund K, Spencer J, Schalla W et al. Estimated public costs of HIV counseling and testing. In: Program and abstracts of the Sixth International Conference on AIDS, June 20–24, 1990; San Francisco, CA. Abstract FD835.
30. Phillips KA, Coates TJ, Eversley RB, Catania JA. Who plans to be tested for HIV or would get tested if no one could find out the results? Am J Prev Med 1995;11:156–62.
31. Higgins DL, Galavotti C, O'Reilly KR, et al. Evidence for the effects of HIV antibody counseling and testing on risk behaviors. JAMA 1991;266:2419–2429.
32. Holtgrave DR, Qualls NL, Curran JW, Valdiserri RO, Guinan ME, Parra WC. An overview of the effectiveness and efficiency of HIV prevention programs. Public Health Reports 1995;110:134–146.
33. Marwick C. Home testing kits for HIV apt to get FDA approval. JAMA 1995;273:908–909.