

**Analysis of the July 2001 Performance Evaluation
HIV-1 Antibody Testing Results
Reported to the Centers for Disease Control and Prevention (CDC)
by Laboratories Participating in the Model Performance Evaluation Program**

This report is an analysis of results provided to the Centers for Disease Control and Prevention (CDC) by laboratories participating in the Model Performance Evaluation Program (MPEP) after they tested the human immunodeficiency virus type 1 (HIV-1) performance evaluation samples shipped to them in July 2001. Testing results were reported by 771 (90.8%) of 849 laboratories that received sample panels.

Samples used in the MPEP surveys are undiluted, defibrinated plasma obtained from individual donors who are HIV-1-infected (positive) or HIV-1-uninfected (negative). The samples were treated with an organic solvent-detergent mixture known to inactivate blood borne viruses including HIV-1, human T-lymphotropic virus, and hepatitis B and C. Before shipment, each donor sample was tested with two HIV-1 enzyme immunoassay (EIA) kits, two HIV-1/HIV-2 EIA kits and one rapid test (RT) kit (SUDS HIV-1) licensed by the Food and Drug Administration (FDA). Supplemental testing was performed with two FDA-licensed HIV-1 Western blot (WB) kits. Donor samples were not tested prior to shipment with any HIV-1 indirect immunofluorescence (IIF) test.

In pre-shipment testing, the strong-positive HIV-1 donor sample (Donor 5) was EIA repeatedly reactive with all of the HIV-1 EIA kits and the HIV-1/HIV-2 EIA kits. It was also WB reactive with the HIV-1 FDA-licensed WB kits. The negative donor sample (Donor 1) was EIA repeatedly non-reactive and demonstrated no bands with any FDA-licensed HIV-1 WB kit. Donor samples 3 and 4, obtained from individual donors recently infected with HIV-1, were weakly positive for HIV-1 antibody and demonstrated variable EIA and WB reactivity with the FDA-licensed EIA, WB and RT kits used for preshipment testing. Testing information for sequential serum samples from Donors 3 and 4 demonstrated factors consistent with seroconversion such as a positive p24 antigen test, positive test for HIV-1 ribonucleic acid (RNA), rising HIV-1 antibody titers in all EIA tests, and WB reactivity changing from nonreactive (no bands) to indeterminate or reactive from one donation to the next.

Figure 1 shows the cumulative frequency of test result interpretations reported by participating laboratories, arranged according to donor reactivity, for the EIA, WB, and IIF methods. Of the 1,448 EIA interpretations reported for the HIV-1-negative sample, three (0.2%) were incorrectly reported as reactive. There were 31 (1.1%) false-negative EIA interpretations among the 2,921 interpretations reported for the HIV-1-positive samples. Of 244 WB interpretations reported for the HIV-1-negative sample, one (0.4%) reactive and seven (2.9%) indeterminate WB interpretations were reported. Among the 1,054 WB interpretations reported for the HIV-1-positive samples, there were 10 (1.0%) false-negative and 128 (12.1%) indeterminate interpretations reported. Among the 33 IIF interpretations reported for the HIV-1-negative sample, there were no false-positive or indeterminate interpretations reported. Of the 127 IIF interpretations reported for HIV-1-positive samples, there were 17 (13.4%) indeterminate and 22 (17.3%) false-negative interpretations.

The types of laboratories that reported results to CDC are shown in Figure 2. Each laboratory type is listed, by decreasing frequency, for each of the test methods.

The combinations of test methods used by the laboratories and the frequency of use are shown in Figure 3. Of the 771 laboratories reporting results, 371 (48.1%) performed only EIA, 230 (29.8%) performed only EIA and a supplemental test, and six (0.8%) performed only a supplemental test. These numbers do not include the 164

(21.3%) laboratories that performed an “Other” test in addition to or instead of EIA, WB and IIF. The data for these “Other” tests are presented in Figure 10.

The types of test kits used, by kit manufacturer, for the EIA, WB, and IIF methods are shown, by decreasing frequency, in Figure 4. For each test method, some laboratories indicated using test kits for which there were no unique manufacturer codes provided in the survey report form and these responses have been grouped as “Other” manufacturer kits. Some “Other” kits reported as being used for EIA include Abbott HIV-1/2 gO EIA (five laboratories) and BioChem ImmunoSystems Detect HIV (four laboratories). Some laboratories, located outside the United States, used the Abbott AXSYM system or the Abbott PRISM analyzer and reported results as S/CO (sample/cutoff ratio). Since the S/CO data can not be entered correctly on the MPEP EIA result form, the data from laboratories using either AXSYM or PRISM systems are reported with “Other” tests in Figure 10.

The results reported for the EIA, WB, and IIF methods, listed by kit manufacturer, for the HIV-1-positive and HIV-1-negative samples are shown in Figures 5, 6, and 7. Results reported by the participant laboratories reflect their testing performance using manufactured kits to evaluate MPEP samples and do not necessarily reflect an evaluation of these manufactured kits.

EIA Results

In Figure 5, the three false positive EIA interpretations were reported for Donor 1 by laboratories using three different EIA kits.

Of the 31 nonreactive EIA interpretations reported for HIV-1 positive samples, 26 (83.9%) were reported for the weak-positive sample Donor 4. Twenty-five (80.7%) of the 31 nonreactive interpretations were reported by laboratories using the Organon Teknika Vironostika HIV-1 kit. Of these, 24 were reported for the weak-positive sample Donor 4. The remaining six false negative interpretations were reported by three laboratories using three different test kits.

WB Results

Of the 771 laboratories reporting test results in this survey, 267 (34.6%) performed WB testing. Some laboratories performed WB testing on donor samples that they reported as nonreactive in EIA tests. One reactive and seven indeterminate WB interpretations were reported by seven different laboratories for the HIV-1 uninfected donor sample (Donor 1), using four different WB kits. All of these laboratories had reported these samples to be nonreactive in EIA tests.

Of the 128 indeterminate WB results reported for samples from the HIV-1-infected donors, 118 (92.2%) were reported for Donor 4, an HIV-1-infected seroconverting donor, nine were reported for Donor 3, and one for Donor 5. Indeterminate WB interpretations were reported by laboratories using WB kits provided by nine different manufacturers (Figure 6). Laboratories using WB kits manufactured by BioRad accounted for 69 (53.9%) of the indeterminate WB results. Of these, 61 were reported for Donor 4, and eight for Donor 3. The 10 nonreactive WB interpretations were reported by 10 different laboratories for Donor 4. Nine of these nonreactive interpretations were reported by laboratories using kits manufactured by BioRad.

The WB bands for the donor samples in this survey, as determined in pre-shipment testing with two FDA-licensed WB test kits, are shown in Table 2. Only bands scoring greater than or equal to 1+ intensity are listed in Table 2.

Of the 267 laboratories reporting WB test results, 249 indicated which WB criteria were used to interpret their WB tests. The ASTPHLD/CDC WB interpretive criteria were used by 209 (83.9%) of these 249 laboratories. The WB interpretive guidelines published by all the FDA-licensed WB kit manufacturers are identical to the ASTPHLD/CDC HIV-1 WB interpretive criteria. Please recall that the Association of State and Territorial Public Health Laboratory Directors (ASTPHLD) is now called the Association of Public Health Laboratories (APHL). Nine laboratories indicated they were using interpretive criteria different from that recommended by the kit manufacturer as licensed by the FDA.

WB Band Patterns

The protein band patterns for the major viral proteins, as reported by participant laboratories for each donor sample, are shown in Figure 8. The frequency of a reported band is listed above the column. The number of WB reports received for the donor sample is indicated in the far right column. This figure does not include WB bands reported as 'W', or "weak", indicating intensity less than that of the designated band of the weak positive control provided in the WB kit nor does it include bands of greater than 1+ intensity reported for p15, p17, p51, p55, or p66. Note that 244 WB results were reported for the sample from an HIV-uninfected donor (Donor 1) although most laboratories do not normally include the testing of EIA-nonreactive donor samples in their routine algorithm for HIV antibody testing.

For the HIV-1 antibody strong-positive sample (Donor 5) and one seroconversion sample (Donor 3), most laboratories had no difficulty in detecting antibodies to gag, pol, and env antigens. The donor samples obtained from the other weakly-reactive seroconversion sample (Donor 4) appeared to cause more difficulty. Indeterminate interpretations reported for this sample most often resulted from failure to detect antibody to envelope (env) antigen gp160, or from failure to detect antibody to env antigen at sufficient intensity to be determined reactive. Eleven laboratories reported indeterminate results, even though the band patterns appeared to fit the reported criteria for reactive results. The CDC WB test results are shown in Table 2 of the results report accompanying this analysis.

IIF Results

No false-positive or indeterminate IIF interpretations were reported for the HIV-1-negative donor sample (Figure 7). Among the 127 IIF interpretations reported for the HIV-1-positive samples, 22 (17.3%) false-negative and 17 (13.4%) indeterminate interpretations were reported. Fourteen (63.6%) of the false negatives were reported for the samples from Donor 4. Eleven (64.7%) of the indeterminate interpretations were reported for the samples from Donor 3.

The IIF intensity patterns for HIV-1 infected cells, as reported by participating laboratories, are shown in Figure 9. The frequency of reports of fluorescence intensity for each donor is listed in the far right column. A scoring of fluorescence intensity is not required for interpretation of seroreactivity with the FDA-licensed Waldheim Fluorognost HIV-1 IFA kit; therefore, some laboratories provided interpretation, but did not score fluorescent intensity. Data from these laboratories were included in Figures 1 and 7, but cannot be included in Figure 9. No fluorescence intensity was reported for the sample from HIV-1-uninfected Donor 1. Nine (15.0%) of the 60 IIF reports received for samples from Donor 3 indicated no fluorescence observed and 14 (45.2%) of the 31 IIF reports received for Donor 4 samples indicated that no fluorescence was observed.

Other Tests Performed

Figure 10 provides information on the test results and interpretations provided by 164 laboratories that performed

HIV-1 antibody tests in addition to or other than traditional EIA, WB or IIF. The first graphic of this figure shows manufacturers of the "Other" types of tests and frequency of use. The rest of this figure shows the results reported by laboratories after testing the HIV-1-negative and HIV-1-positive samples in this shipment. Sixty (36.6%) of the 164 laboratories reporting results of "Other" types of tests did not report results using EIA, WB or IIF tests. The procedures used by 103 (62.8%) of these 164 laboratories can be described as "rapid tests". Of these, 68 (66.0%) laboratories reported using Murex/Abbott SUDS-HIV-1, 15 (14.6%) tested samples using Fujirebio Serodia HIV, and seven (6.8%) laboratories reported using Abbott Determine. Results of "Line or Strip Immunoassay" tests such as Innogenetics INNO-LIA, Organon Teknika Liatek and Chiron RIBA were reported by 24 laboratories. Note that all laboratories using the Abbott AXSYM or PRISM systems correctly reported their results on the "Other" test type result form since these tests are based on microparticle capture and chemiluminescence measurements, and differ from the traditional microtiter-format EIA tests.

Among the 333 final interpretations reported for HIV-1-negative sample (Donor 1) tested by laboratories using these "Other" procedures, 60 false-positive interpretations were reported by 35 laboratories using three different test systems. Fifty-five (91.7%) of the false positive interpretations were from laboratories using the Murex/Abbott SUDS-HIV-1 test. Of the eight indeterminate interpretations reported, seven were from laboratories using the SUDS HIV-1 test.

Among the 735 interpretations reported for the HIV-1-positive samples tested by procedures other than EIA, WB, or IIF, there were 63 (8.6%) false-negative and 14 (1.9%) indeterminate interpretations. Fifty-eight (92.1%) of the false-negatives and eight (57.1%) of the indeterminates were reported for samples from Donor 4. Sixty-two (98.4%) of the false negative results were reported from 58 of the 68 laboratories using the SUDS HIV-1 test. Nine laboratories reported 14 indeterminate interpretations using eight different test kits.

Quality Control Testing

Information was sought on the use of quality control (QC) samples other than the controls provided in various test kits. Positive and negative samples included in manufactured kits are internal kit control material used to validate the test run, calculate test run cut-off values, and may not validate the analytic testing process which may include testing problems such as faulty pipettors, inadequate incubation conditions, or kit lot sensitivity. Most laboratories completing the QC section of the form adhered to the instructions pertaining to this section and described only external QC samples used in their HIV testing procedures.

Of the 694 laboratories that reported EIA test results, 486 (70.0%) indicated they used quality control samples other than those provided with the manufactured test kit. Of these 486 laboratories, 293 (60.3%) used samples obtained commercially, 161 (33.1%) used QC samples from in-house sources, and 27 (5.6%) used QC material from both commercial and in-house sources. Five laboratories did not indicate the source of their external QC samples. The majority indicated the use of weakly-positive and negative serum/plasma with each set/run of plates or each EIA plate.

Of the 267 laboratories reporting WB test results, 93 (34.8%) laboratories used external QC samples. Of these 93 laboratories, 59 (63.4%) used samples prepared in-house, 31 (33.3%) used QC samples obtained commercially, and two (2.2%) used QC material from both commercial and in-house sources. One laboratory did not indicate the source of external QC samples used in WB. Most laboratories used weakly-positive serum/plasma with each set/run of WB strips.

Of the 34 laboratories reporting IIF results, 13 (38.2%) used IIF external QC samples. Of these, nine (69.2%) used samples from in-house sources, and four (30.8%) used QC samples obtained commercially. Most of the 13 laboratories included multiple-reactivity external QC samples with each set/run of slides or kit.

Of the 164 laboratories reporting results of tests other than EIA or WB or IIF, 49 (29.9%) indicated the use of external QC samples. Of these, 31 (63.3%) used samples from in-house sources and 17 (34.7%) used samples from commercial sources. One used samples from both commercial and in-house sources. The majority of these laboratories indicated they used at least a weakly-positive QC sample with each set/run.

Conclusion

The MPEP provides challenging samples for participant laboratories to perform HIV-1 antibody testing. Most participant laboratories performed well in testing the HIV-1 donor samples in this shipment. However, samples from the weakly-positive seroconverting Donor 4 caused some difficulty. Some false-negative results were reported for traditional EIA (1.1%), WB (1.0%) and IIF (17.3%) with HIV-1-positive samples. Also, a few false-positive EIA (0.2%) and WB (0.4%) results were reported for samples negative for HIV-1 antibody (Donor 1). No false-positive IIF results were reported in this survey. Some laboratories that performed testing using the Murex/Abbott SUDS HIV-1 test kit reported both false-positive results for the HIV-1 uninfected Donor 1 and false-negative results for the weakly-positive Donor 4.

The following information regarding overall analytic performance, analytic sensitivity, and analytic specificity is determined from the results reported by laboratories testing performance evaluation samples and is not intended to reflect the actual sensitivity and specificity of the manufactured test kits. For this survey, the overall EIA analytic sensitivity and specificity was 98.9% and 99.8%, respectively. When indeterminate and reactive WB interpretations are combined, the WB analytic sensitivity was 99.1%. If indeterminate interpretations are considered incorrect for HIV-1 antibody-negative samples, the WB analytic specificity for this survey was 96.7%. When indeterminate and reactive IIF interpretations are combined for the HIV-1-positive samples, the IIF analytic sensitivity was 82.7%. The IIF analytic specificity was 100% for this survey. The analytic sensitivity and specificity of the "Other" test procedures vary greatly, depending on which test method results are analyzed (Figure 10). When indeterminate WB and IIF interpretations for the HIV-1 antibody-positive samples are combined with reactive interpretations, the overall analytic performance for laboratories testing these performance evaluation samples by EIA, WB, and IIF procedures was 99.2%, 98.6%, and 86.3% respectively.

Please note that we plan to ship the next panel of MPEP HIV-1 antibody samples to participating laboratories on January 8, 2002, to laboratories located outside the United States and on January 22, 2002, to laboratories located within the United States.