Molecular specificity of two commercial enzyme linked immunosorbent assays for human immunodeficiency virus antigens

K E Brown, D C Shanson, P Mascagni, A R M Coates

Abstract
Only "fair" agreement has been shown between the Abbott and DuPont enzyme linked immunosorbent assays when used for the detection of human immunodeficiency virus (HIV) antigen in serum samples from asymptomatic HIV antibody positive homosexual men. To investigate the discrepancies between the two ELISA results, further experiments were performed. The rabbit detector antibody solutions of both tests were western blotted and showed that the DuPont test was specific for p24; the Abbott detector antibody had bands for p18, p41, p43, gp120 as well as p24. By using dilutions of a known amount of HIV antigen, the Abbott test could detect 20 pg/ml p24; the DuPont test could detect 30 pg/ml p24. The DuPont test was also more sensitive than the Abbott test at detecting a synthetic 104mer peptide of p24. Within the 104mer sequence two regions (294-318, 334-348 amino acids) inhibited the binding of the DuPont detector antibody, but no blocking was observed with the Abbott antibody.

Although the Abbott test was slightly more sensitive at detecting HIV protein than the DuPont test, the major difference between the tests was in the molecular specificity, in that the Abbott test detected proteins other than p24. This may not be important for detecting antigen in cell culture, but it may affect the detection of antigenaemia in patients' sera.

Human immunodeficiency virus (HIV) antigen tests are widely used to monitor patients with HIV infection. HIV antigen can be detected in the serum before antibody seroconversion, but it then disappears in most cases as antibody titres become detectable. Patients who have persistent HIV antigenaemia seem to be at a higher risk of developing AIDS. HIV antigen tests have been recommended as a useful index for starting and monitoring patients on antiviral treatment.

Two commercially available HIV antigen assays (Abbott HTLV III Antigen test and the DuPont HIV p24 test) are widely used for these assays. We have previously tested asymptomatic HIV antibody positive homosexual men using both tests, and shown only "fair" agreement between the results of the two tests. In this study we examined the relative sensitivities and molecular specificities of the assays in an attempt to account for the discrepancies between the tests.

Methods
SENSITIVITY AND CALIBRATION OF THE ASSAYS
A series of dilutions were made from a viral lysate containing 200 ng/ml p24 (800 ng/ml total HIV protein) (EI DuPont de Nemours and Co.). The resultant solutions were tested (in duplicate) in both ELISA systems using the manufacturer's protocol. By incorporating each ELISA's own test standards, each assay could also be calibrated against the known antigen titre.

SPECIFICITY OF THE ASSAYS
Western blotting of the rabbit detector antibody
Nitrocellulose strips with pre-electrophoresed HIV proteins (BioRad Laboratories Ltd, Watford) were washed on a side to side rocker for two hours in phosphate buffered saline (PBS) containing 5% bovine serum albumin (BSA). The strips were then incubated overnight with 1.5 ml of detector antibody in 1.5 ml PBS containing 1% BSA and 0.05% Tween 20.

After washing three times in PBS the strips were incubated for two hours at room temperature with a 1 in 250 dilution of anti-rabbit IgG biotin conjugate (Amersham). The strips were rewashed three times in PBS and reincubated for two hours at room temperature in a 1 in 250 dilution of streptavidin-horseradish peroxidase (Amersham). After final washes in PBS the colour was developed using 1 volume of 3 mg/ml 4-chloro-l-naphthol in methanol and 5 volumes of TRIS buffered saline containing 0.003% H2O2.

Synthetic peptides
A synthetic 104mer peptide (104 amino acids from the C-terminus of p24) was assayed in both the Abbott and DuPont HIV ELISAs to detect their relative sensitivities to this gag protein. A synthetic RNAse was used as a control preparation for these experiments.

To determine the key epitopes involved in binding, competitive blocking of epitopes was attempted using short synthetic peptides (15

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Molecular specificity of two ELISAs for HIV antigens

Figure 1 Results of testing dilutions of known standard in Abbott and DuPont ELISAs

Figure 2 Results of western blotting with three detector antibody solutions (A) Control (human HIV antibody positive serum); (B) Abbott polyclonal detector antibody; (C) DuPont monoclonal detector antibody.

Amino acids in length. Each well of a poly-tyrene microtitre plate (Dynatech Laboratory) was coated with 50 μl of 20μg/ml 104mer and allowed to dry overnight. The non-specific binding was then “blocked” with 5% BSA in PBS (two hours at room temperature) and washed with PBS plus 0.05% Tween 20 (PBST).

Each rabbit detector antibody solution (250 μl) was preincubated at 37°C for two hours with 25 μl of 50 μg/l solution of short peptide, before 100 μl of each mixture was added to each of the “104mer coated” wells and incubated at 37°C for one hour. After washing with PBST 100 μl of a second detector solution (goat antirabbit horseradish peroxidase for the Abbott test; streptavidin-horseradish peroxidase for the DuPont test) was added to each well and incubated at 37°C for one hour. A final wash with PBST 100 μl of OPD was added and the reaction stopped after 30 minutes with 100 μl of 1 M H₂SO₄. The plate was read in the plate spectrophotometer at 492 nm. The whole experiment was done in duplicate.

Results

Sensitivity of the Assays

Both tests showed similar sensitivities. Although the Abbott test appeared more sensitive, detecting 20 pg/ml p24, whereas the DuPont test could only detect 30 pg/ml p24 (fig 1), this difference was not significant.

The Abbott test quantified the level of antigen in U/ml of antigen, with a conversion factor of about 1-7 pg p24/U (table 1). The DuPont test claimed to give the result as pg p24, but calibrating against a known control it appeared to underestimate the amount of antigen (conversion factor 1-7 DuPont pg/pg p24), (table 1). Thus there was a threefold difference in the level of antigen recorded by the two assays.

Specificity of the Abbott and DuPont Tests

Western Blotting

From the manufacturer’s data sheet, it seemed that the DuPont ELISA should just detect p24; the Abbott ELISA, using a polyclonal antibody against whole HIV, might detect other antigenic epitopes as well as p24. The results of the western blotting confirmed this (fig 2). The DuPont strip showed only one band at p24. The Abbott strip showed a similar band at p24, but also bands at p18, p41–43, and a very weak band at gp120.

Synthetic 104mer Peptide

The Abbott test could detect about 400 pg/ml of the 104mer; the DuPont test could detect about 100 pg/ml (table 2).

The Abbott test became saturated at 8 ng/ml 104mer, and despite raising the concentration to 1000 ng/ml the optical density did not approach the reading of the Abbott positive control.

In the DuPont assay about 1-3 ng/ml of the 104mer was equivalent to the 250 pg/ml positive control (or 480 pg/ml p24 using the conversion factor calculated above).

The results for the competitive blocking using short peptides are given in table 3. None of the short peptides affected the binding of the Abbott rabbit antibody to the 104mer. Three of the peptides partially blocked the binding of the DuPont rabbit antibody. These data suggest that there are binding sites for the DuPont antibody between the p24 amino acid residues 294–318 and 334–348.

Discussion

The results of this study suggest that the Abbott and DuPont tests have similar sensitivities. Although there are limited data on the relative sensitivities of the two ELISAs for the detection of antigenaemia, several studies have looked at the ability of the two tests to detect antigen in cell culture supernatant. Jackson et al evaluated the Abbott and DuPont antigen ELISAs and found that the Abbott test detected antigen earlier (mean 6-2 days compared with mean 7-4 days for the DuPont).8

The DuPont ELISA, however, was modified in December 1987 and it is not clear whether the original or modified ELISA was used in their study. Healey et al, using the original HIV antigen test showed that the DuPont could detect 70 pg/ml HIV protein (about 18 pg/ml p24); the Abbott test was slightly less sensitive and had a detection limit of 130 pg/ml (35 pg/ml p24).9

Barin et al and Crowe et al, (Programme and Abstracts of the IVth International Conference on AIDS; Stockholm 1988) studied the sensitivity of the two tests on serum samples and showed a discrepancy between the titres of antigen detected in the two tests. The Abbott
Table 2  Comparison of ability of Abbott and DuPont ELISAs to detect synthetic 104 peptide fragment of p24

<table>
<thead>
<tr>
<th>Peptide</th>
<th>Optical density</th>
<th>Abbott test</th>
<th>DuPont test</th>
</tr>
</thead>
<tbody>
<tr>
<td>10⁴mer</td>
<td>10⁵ng/ml</td>
<td>0.677</td>
<td>0.638</td>
</tr>
<tr>
<td></td>
<td>2 x 10⁴ng/ml</td>
<td>0.640</td>
<td>0.644</td>
</tr>
<tr>
<td></td>
<td>8 x 10⁴pg/ml</td>
<td>0.674</td>
<td>0.638</td>
</tr>
<tr>
<td></td>
<td>2 x 10⁵pg/ml</td>
<td>0.410</td>
<td>0.296</td>
</tr>
<tr>
<td></td>
<td>10⁴pg/ml</td>
<td>0.116</td>
<td>0.500</td>
</tr>
<tr>
<td></td>
<td>500 pg/ml</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td></td>
<td>250 pg/ml</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td></td>
<td>125 pg/ml</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td></td>
<td>63 pg/ml</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td></td>
<td>32 pg/ml</td>
<td>NT</td>
<td>NT</td>
</tr>
</tbody>
</table>

Table 3  Results of blocking rabbit detector antibody solutions with short synthetic peptides before testing against 104mer peptide

<table>
<thead>
<tr>
<th>Peptide</th>
<th>Abbott antibody Mean OD 0 452 (SD 0 028)</th>
<th>DuPont antibody Mean OD 0 452 (SD 0 022)</th>
</tr>
</thead>
<tbody>
<tr>
<td>274-288</td>
<td>0 448</td>
<td>1 069</td>
</tr>
<tr>
<td>286-296</td>
<td>0 456</td>
<td>1 021</td>
</tr>
<tr>
<td>294-308</td>
<td>0 408</td>
<td>0 751*</td>
</tr>
<tr>
<td>304-318</td>
<td>0 401</td>
<td>0 779*</td>
</tr>
<tr>
<td>314-328</td>
<td>0 408</td>
<td>0 884</td>
</tr>
<tr>
<td>324-338</td>
<td>0 485</td>
<td>0 958</td>
</tr>
<tr>
<td>334-348</td>
<td>0 453</td>
<td>0 712*</td>
</tr>
</tbody>
</table>

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10 Goudsmit J, Paul DA. Circulation of HIV antigen in blood according to stage of infection, risk group, age and geographic origin. Epidemiol Infect 1987;99:701-10.
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