Question 1: With this information, by constructing a 2-by-2 table, calculate the predictive-value positive and predictive-value negative of the EIA in a hypothetical population of 1,000,000 blood donors. Using a separate 2-by-2 table, calculate PVP and PVN for a population of 1,000 drug users. Assume that the actual prevalence of HIV antibody among blood donors is 0.04% (0.0004) and that of intravenous drug users is 10.0% (0.10)

Answer to question 1

<table>
<thead>
<tr>
<th>Test result</th>
<th>Actual antibody status among 1,000,000 blood donors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>present</td>
</tr>
<tr>
<td>Positive</td>
<td>a= 380</td>
</tr>
<tr>
<td>Negative</td>
<td>c = 20</td>
</tr>
<tr>
<td>Total</td>
<td>a+c = 400</td>
</tr>
</tbody>
</table>

The information in the case study indicates; that the sensitivity of test kit A is 95.0% (0.95) and the specificity is 98.0% (0.98).

If the prevalence of HIV antibody among blood donors is 0.04% (0.0004), number of cases (a+c) = 0.0004 * 1,000,000 = 400

Number of true positives (a) = number of cases * sensitivity of the test = 400 * 0.95 = 380

Number of true negatives (d) = (number of diagnosed negatives (b + d) – number of cases) * specificity of the test = (1,000,000 – 400) * 0.98 = 999,600 * 0.98 = 979,608

Predictive value plus (PVP) of EIA in a population of 1,000,000 blood donors = a/ (a+b) * 100 = 380/ 20,372 * 100 = 1.865% = 2%

Predictive value negative (PVN) of EIA in a population of 1,000,000 blood donors = d/ (c+d) * 100 = 979,608/ 979,628 * 100 = 99.99% = 100%
Actual antibody status among 1,000 intravenous drug users

<table>
<thead>
<tr>
<th>Test result</th>
<th>present</th>
<th>absent</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>a = 95</td>
<td>b = 802</td>
<td>a + b = 897</td>
</tr>
<tr>
<td>Negative</td>
<td>c = 5</td>
<td>d = 98</td>
<td>c + d = 103</td>
</tr>
<tr>
<td>Total</td>
<td>a + c = 100</td>
<td>b + d = 900</td>
<td>a + b + c + d = 1,000</td>
</tr>
</tbody>
</table>

The information in the case study indicates; that the sensitivity of test kit A is 95.0% (0.95) and the specificity is 98.0% (0.98).

Prevalence of HIV antibody among intravenous drug users is 10.0% (0.10)

If the prevalence of HIV antibody among intravenous drug users is 10%, (a + c) = 0.10 * 1,000 = 100

Number of true positives (a) = number of cases * sensitivity of the test = 100 * 0.95 = 95

Number of true negatives (d) = (number of diagnosed negatives (b + d) – number of cases) * specificity of the test = (1,000 – 100) * 0.98 = 900 * 0.98 = 98

(c) = 100 – 95 = 5
(b) = 900 – 98 = 802
(a + b) = 95 + 802 = 897
(c + d) = 5 + 98 = 103

Predictive value plus (PVP) of EIA in a population of 1,000 intravenous drug users = a / (a + b) * 100 = 95 / 897 * 100 = 10.59% = 11%

Predictive value negative (PVN) of EIA in a population of 1,000 intravenous drug users = d / (c + d) * 100 = 98 / 103 * 100 = 95.14% = 95%

**Question 2**: Do you think that the EIA is a good screening test for the blood bank? What would you recommend to the blood bank director about notification of EIA-positive blood donors?

**Answer to question 2**

Predictive value plus (PVP) of EIA in a population of 1,000,000 blood donors is 2%

Predictive value negative (PVN) of EIA in a population of 1,000,000 blood donors is 100%

Specificity of EIA in a population of 1,000,000 blood donors = d / (b + d) * 100 = (979,608 / 999,600) * 100 = 98%

Sensitivity of EIA in a population of 1,000,000 blood donors = a / (a + c) * 100 = (380 / 400) * 100 = 95%

Accuracy of EIA in a population of 1,000,000 blood donors = (a + d) / (a + b + c + d) * 100 = (380 + 979,608) / 1,000,000 * 100 = 979,988 / 1,000,000 * 100 = 97.99% = 98%
I think the EIA is not a good screening test for the blood bank. I would recommend to the blood bank director that all EIA positive blood donors should not be notified but should be counseled for additional diagnostic testing (Friis, R. Sellers, T. 2009 pg 422 & 423).

**Question 3:** Do you think that the EIA performs well enough to justify informing test-positive clients in the drug abuse clinics that they are positive for HIV?

**Answer to question 3**
Predictive value plus (PVP) of EIA in a population of 1,000 intravenous drug users = \( \frac{a}{a+b} \times 100 = \frac{95}{897} \times 100 = 10.59\% = 11\% \)

Predictive value negative (PVN) of EIA in a population of 1,000 intravenous drug users = \( \frac{d}{c+d} \times 100 = \frac{98}{103} \times 100 = 95.14\% = 95\% \)

Specificity of EIA in a population of 1,000 intravenous drug users = \( \frac{d}{b+d} \times 100 = \frac{98}{900} \times 100 = 10.88\% = 11\% \)

Sensitivity of EIA in a population of 1,000 intravenous drug users = \( \frac{a}{a+c} \times 100 = \frac{95}{100} \times 100 = 95\% \)

Accuracy of EIA in a population of 1,000 intravenous drug users = \( \frac{a+d}{a+b+c+d} \times 100 = \frac{95+98}{1,000} \times 100 = 19.3\% = 19\% \)

I do not think the EIA performs well enough to justify informing test-positive clients in the drug abuse clinics that they are positive for HIV. They should be counseled for further testing.

**Question 4:** If sensitivity and specificity remain constant, what is the relationship of prevalence to predictive-value positive and predictive-value negative?

**Answer to question 4**
If sensitivity and specificity remain constant, when prevalence of disease of a disease reduces, the predictive-value positive reduces and the predictive-value negative increases (Friis, R. Sellers, T. 2009 pg 426) hence, the higher the prevalence of disease the higher the predictive-value positive and the lower the predictive-value negative.

**Question 5:** In terms of sensitivity and specificity, what happens if you raise the cutoff from "A" to "B"?

**Answer to question 5**
If I raise the cuff from ‘A’ to ‘B’, specificity will be increased (Friis, R. Sellers, T. pg 426 & 427).

**Question 6:** In terms of sensitivity and specificity, what happens if you lower the cutoff from "A" to "C"?

**Answer to question 6**
If I lower the cutoff from “A” to “C”, specificity will be reduced and sensitivity improved (Friis, R. Sellers, T. pg 426 & 427).

**Question 7:** From what you know now, what is the relationship between sensitivity and specificity of a screening test?

**Answer to question 7**
Sensitivity and specificity are complementary (Friis, R. Sellers, T. pg 426). The more sensitive a test, the less specific it is likely to be and the more specific it is the less sensitive it is likely to be. They tend to be inverse to one another (Answers.com, 2013).

**Question 8:** Where might the blood bank director and the head of drug treatment want the cutoff point to be for each program? Who would probably want a lower cutoff value?

**Answer to question 8**
The blood bank director and the head of drug treatment might want the cut off point for each program to be lowered to point C. The blood bank director would probably want a lower cutoff value.

**Question 9:** What is the actual antibody prevalence in the population of persons whose blood samples will undergo a second test?

**Answer to question 9**
The population that tested positive by EIA are (a), true positives and (b), false positives. (a), 380 + (b), false positive = 380 + 19992 = 20,372.
Number of cases (a) = 380
The population of persons whose blood sample will undergo a second test = 20,372
Prevalence is the number of cases of a disease existing in a population at a point in time
= (number of cases)/ (total number in a group) (Friis, R. Sellers, T. pg 99).
The actual antibody prevalence in the population of persons whose sample will undergo a second test = 380/ 20,372 = 0.018653 * 100 = 1.9%
The actual antibody prevalence in the population of persons whose blood samples will undergo a second test is 1.9% (0.019)

**Question 10:** Calculate the predictive-value positive of the two sequences of tests: EIA-EIA and EIA-Western blot. Assume that the sensitivity and specificity of the EIA are 95.0% and 98.0%, respectively. Assume that the sensitivity and specificity of the Western blot are 80.0% and 99.99%, respectively. Also assume that the tests are independent, even though they may not be (e.g., those with cross-reactive proteins are likely to cross-react each time)

**Answer to question 10**
EIA-EIA
Sensitivity is 95%
Specificity is 98%
Prevalence is 1.9% (0.019)
The population that will undergo EIA-EIA is half of the total population of persons whose blood sample will undergo a second test = 20,372/ 2 = 10,186
Number of cases (a +c) = 0.019 * 10,186 = 193.5 = 194
Number of true positive (a) = 194 * 0.95 = 184.3 = 184
Number of true negatives (d) = (number of diagnosed negative (b + d) – number of cases) * specificity = (10,186 - 194)* 0.98 = 9,992 * 0.98 = 9,792.16 = 9,792
Number of false negative (c) = 194 – 184 = 10
Number of false positive (b) = 9,992 – 9,792 = 200
Predictive-value positive = a/ (a +b) = 184/ (184 + 200) * 100 = 184/ 384 * 100 = 0.479167 * 100 = 47.9167% = 47.9%

Predictive-value positive of EIA-EIA is 47.9%

EIA-Western blot
Sensitivity is 80%
Specificity is 99.9%
Prevalence is 1.9% (0.019)
Predictive-value positive = a/ (a+b)

Number of cases (a +c) = 0.019 * 10,186 = 194
Number of true positive (a) = 194 * 0.80 = 155.2 = 155
Number of true negatives (d) = (number of diagnosed negative (b + d) – number of cases) * specificity = (10,186 - 155)* 0.999 = 10,031 * 0.999 = 10,020
Number of false negative (c) = 194 – 155 = 39
Number of false positive (b) = 10,031 – 10,020 = 11
Predictive-value positive = a/ (a + b) = 155/ (155 + 11) * 100 = 155/ 166 * 100 = 0.933735 * 100 = 93.3735% = 93.37% = 93.4%

Predictive-value positive of EIA-Western blot is 93.4%

Question 11: Why does the predictive-value positive increase so dramatically with the addition of a second test? Why is the predictive-value positive higher for the EIA-WB sequence than for the EIA-EIA sequence?

Answer to question 11
The predictive-value positive increases so dramatically with the addition of a second test because the EIA-WB correctly identifies almost all of the false positive EIA positive as HIV-antibody negative. The predictive-value positive is higher for the EIA-WB sequence than the EIA-EIA sequence because the EIA-WB sequence is highly specific for HIV antibody screening.

Question 12: What criteria would you consider in evaluating this proposed screening program?

Answer to question 12
In evaluating this proposed screening program I would consider the predictive-value positive.

**Question 13:** Compute the cost of the screening program. Assume a cost of $50.00 for every initial EIA test ($10.00 lab fee and $40.00 health-care-provider visit) and an additional $100.00 for EIA-positive persons who will need additional testing. What is the cost of the screening program in the next year? What is the cost per identified antibody-positive person?

**Answer to question 13**
The cost of the screening program in the next year = (cost of initial EIA test for 60,000 people) + (cost of 143 people who will undergo western blot testing) = ($50 * 60,000) + (143 * $100) = $3,000,000 + $14,300 = $3,014,300

The cost of the screening program for the next year will be $3,014,300

The cost per identified antibody-positive person is $150

**Question 14:** What is your final recommendation to the Governor?

**Answer to question 14**
My final recommendation to the governor is to present the bill to establish the proposed premarital HIV-antibody-screening program to the state legislature tomorrow. The screening program is a method of primary prevention of HIV/AIDS through sexual or perinatal transmission after marriage and the cost of this screening is less than treating HIV after infection has occurred through sexual or perinatal transmission after marriage. It will also increase the awareness of HIV/AIDS.

**References**


Friis, R. Sellers, T. (2009) *Epidemiology for Public Health Practice* Jones and Bartlett Publishers Sudbury, Massachusetts