As is true of all serologic tests, those used to diagnose syphilis are fallible. The sensitivity, specificity, and predictive values of the serologic tests must also be considered in the interpretation of laboratory results. Sensitivity is considered to be the percentage of reactive results obtained in a population of persons with syphilis; specificity is defined as the percentage of nonreactive results obtained in a population of persons without syphilis. Thus, the sensitivity of a test is calculated from the number of true positives (TP) detected in a diseased population divided by the number of true positives (TP) detected in a diseased population divided by the number of false-negative (FN) results. The formula used to determine sensitivity is as follows:

\[
\% \text{ Sensitivity} = \frac{\text{TP}}{\text{TP} + \text{FN}} \times 100
\]

For example, in a population of 50 individuals with darkfield positive lesions, when the VDRL is reactive in 48 (TP) and nonreactive in 2 (FN), the sensitivity of the test is 96%, or:

\[
\frac{48}{48 + 2} \times 100
\]

To determine specificity, the test is used with serum samples from persons without syphilis, and the formula used to calculated specificity reflects the possibility of obtaining false-positive (FP) results:

\[
\% \text{ Specificity} = \frac{\text{TN}}{\text{TN} + \text{FP}} \times 100
\]

For instance, the VDRL is used to screen a population of 50 persons without active syphilis and the results include 47 nonreactive (TN) and 3 reactive (FP) test results. Thus, the specificity of the VDRL is 94% or:

\[
\frac{47}{47 + 3} \times 100
\]

In most instances in which tests are used as screening procedures, such as the nontreponemal tests in a premarital population, the disease status of the individual is unknown. When a positive predictive value (PPV) is determined based on either the prevalence of the disease in a population or by clinical estimate of the probability of the disease in a given patient, the PPV is known as the pretest or a posteriori probability and is calculated by using the following formula.

\[
\% \text{ PPV} = \frac{\text{sensitivity} \times \text{prevalence}}{\text{sensitivity} \times \text{prevalence} + (1 - \text{prevalence})(1 - \text{specificity})} \times 100
\]
Assuming the prevalence of syphilis in a premarital population to be 10% and then using the sensitivity and specificity determined for the VDRL, one can determine the a posteriori predictive value as follows:

\[
\% \text{ PPV} = \frac{0.96 \times 0.1}{0.96 \times 0.1 + (1 - 0.1)(1 - 0.94)} \times 100
\]

\[
\% \text{ PPV} = \frac{0.096}{0.096 + (0.90)(0.06)} \times 100
\]

\[
\% \text{ PPV} = \frac{0.096}{0.15} \times 100
\]

\[
\% \text{ PPV} = 64\%
\]

In other words, a reactive result predicts true cases of syphilis 64% of the time; 36% of the time, the test result is a false positive. The accuracy of the laboratory test result is most strongly influenced by the specificity of the test and the prevalence of the disease. The interrelationship of a reactive test result and the prevalence of syphilis at various levels of test specificity is shown in Figure 1:1.

Although the specificities of the VDRL and FTA-ABS tests are quite similar (Chapter 1, Tables 1:2, 1:4), screening with the VDRL to increase the prevalence of the disease in samples to be confirmed with the FTA-ABS improves the PPV value of the FTA-ABS. In our example, by screening with the VDRL we increased the prevalence of syphilis to 64% in the serum samples
to be tested with the FTA-ABS test. Assuming that both the sensitivity and the specificity of the FTA-ABS test are 98%, the a posteriori predictive value of a reactive FTA-ABS test can be calculated as follows:

$$\% \text{ PPV} = \frac{0.98 \times 0.64}{0.98 \times 0.64 + (1 - 0.64)(1 - 0.98)} \times 100$$

$$\% \text{ PPV} = \frac{0.6272}{0.6272 + (0.36)(0.02)} \times 100$$

$$\% \text{ PPV} = \frac{0.6272}{0.6344} \times 100$$

$$\% \text{ PPV} = 99\%$$

In other words, reactive results both in the VDRL and in the FTA-ABS can predict infection with *T. pallidum* 99% of the time.