Cardiology Lab Essentials
Chapter 1

THE IMPORTANCE OF THINKING AHEAD

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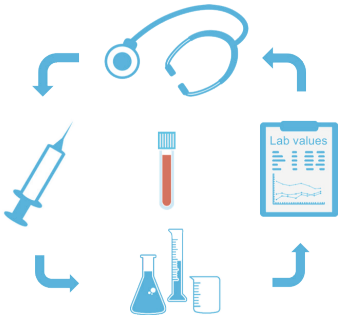
GOING ON A JOURNEY WITH YOUR BLOOD SAMPLE

Total testing process

The total testing process is comprised of the preanalytical phase, the analytical phase, and the postanalytical phase.



Preanalytical phase

The preanalytical phase covers everything that happens before the sample is actually analyzed. This includes the planning the request, the sample collection itself, the transport to the lab, and also the storage of the sample before analysis.

Important factors to consider

- Timing of sample collection
- Tube additive
- Physical activity
- Drugs
- Patient identification
- Blood collection technique
- Filling of the tube
- Transport
- Processing
- Storage

Analytical phase

The analytical phase is all about the analysis of the sample itself. The lab must ensure that the test itself is performed correctly, producing accurate test results. This can be achieved by maintaining the equipment, avoiding mix-ups, accounting for interference, and using quality control measures to ensure best practice.

Postanalytical phase

The postanalytical phase is comprised of the verification and review of results by technicians and laboratory doctors, the reporting of results in a timely manner—mostly via an electronic information system, and the interpretation of results by the attending clinician.

Errors in any of these phases can lead to inappropriate clinical decisions and even misdiagnosis of patients. Thus, it is important to reduce errors in the total testing process to a minimum..

AVOIDING MISTAKES IN SAMPLE COLLECTION

There are uncontrollable and controllable factors that influence lab results.

Uncontrollable factors

Uncontrollable factors include

- Age
- Gender
- Ethnicity and
- Pregnancy

Most laboratory computer systems adjust reference ranges on the lab report according to these uncontrollable factors.

Controllable factors

Diet

Some lab analytes are influenced by food intake. For example, triglyceride levels increase by up to 78% within two hours after consuming a standard meal. Thus, some lab markers require fasting.

Fasting recommendations

- No food for 12 hours
- No alcohol for 24 hours
- Blood collection between 7 am and 9 am
- No caffeine before blood collection
- No smoking before blood collection

Procedures

Dilution

When you draw blood from the same line where an IV infusion is given, it is possible to draw some of this fluid into your tube. This leads to falsely low results due to the dilution of your blood sample and should be avoided.

Surgery

Shortly after surgery, D-dimers will unavoidably increase even without an underlying thrombotic event. Since D-dimers can stay elevated for days to weeks, it makes no sense to measure them in this setting.

Hemolysis

Hemolysis leads to the release of intracellular components like potassium, magnesium, phosphate, lactate dehydrogenase, and aspartate aminotransferase, thus leading to falsely elevated blood levels.

There are two kinds of hemolysis:
In vitro hemolysis–caused by faulty blood sampling.
In vivo hemolysis–results from a pathological condition taking place in the patient.
–accounts for only 3% of hemolyzed samples in the lab.

Recommendations on how to avoid in vitro hemolysis

- *Avoid having your patients pump their fist before puncture*
- *Do not leave the tourniquet on for longer than 1 minute*

UNDERSTANDING SENSITIVITY AND SPECIFICITY

Sensitivity and specificity

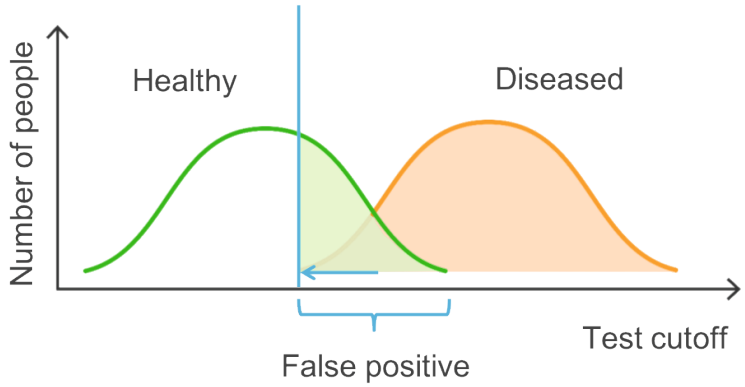
Sensitivity and specificity are used to describe how well my test of interest performs at addressing a certain clinical question. We also call this the validity of the test.

In medicine, tests are designed to separate healthy from diseased individuals. In real life, no test is able to differentiate between healthy and diseased individuals 100% of the time, so there is always some overlap.

For quantitative tests we use cutoff levels to help us classify our patients. Depending on where we put our cutoff level, we will increase either our sensitivity or our specificity.

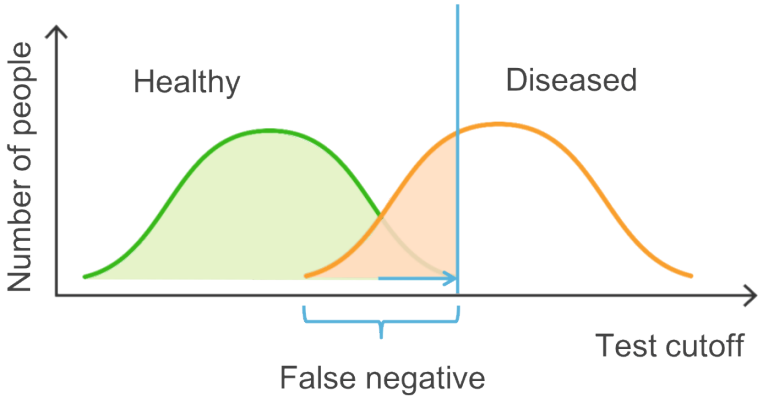
High sensitivity

When you want to catch all diseased patients with your test, you should aim for high sensitivity. To do this, you can adjust your test validity by setting your cutoff level low.
Unavoidably some healthy people will now test positive as well. We call these false positive results.



High specificity

When you want to catch all healthy patients with your test, you should aim for high specificity. To do this, you can adjust your test validity by setting your cutoff level high.
Unavoidably some diseased people will now test negative as well. We call these false negative results.



Sensitivity and specificity act in opposite directions. When we set the sensitivity higher, specificity will be lower, and vice versa.

INTERPRETING PREDICTIVE VALUES

Predictive values

Predictive values help us to interpret whether a patient is healthy or diseased based on their lab result. We determine the positive predictive value (PPV) and the negative predictive value (NPV).

Positive predictive value

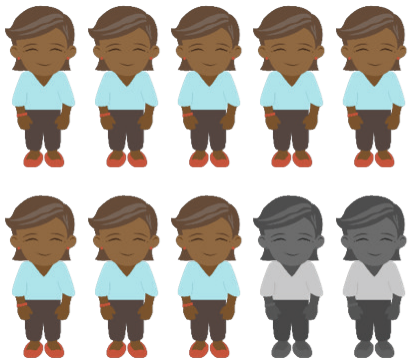
The positive predictive value tells us, of those individuals who test positive, what percentage actually have the disease. Or of all the patients with a positive test result, how many are truly positive and not falsely positive?

A high positive predictive value helps us to **rule in** disease in a patient.

Negative predictive value

The negative predictive value tells us, of all the individuals who test negative, what percentage really do not have the disease in question. Or of all the patients with a negative test results, how many are truly negative and not falsely negative?

High negative predictive value helps us to **rule out** disease in a patient.

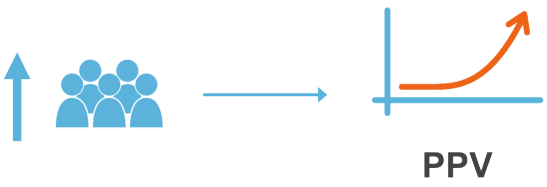


Increasing the positive predictive value

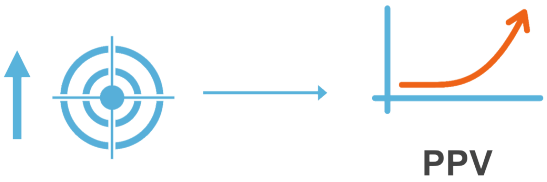
To rule in a disease, you want to use a test with a high positive predictive value. That way the chance of falsely positive results is lowest.

Unfortunately, the positive predictive value of a test can change depending on the situation.

There are two ways to increase the PPV



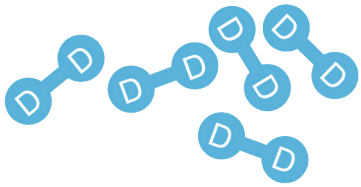
1. You can increase the prevalence of the disease in your population by only testing patients with a high likelihood of having the disease. Scores and other diagnostic tools can help you find out how likely it is that your patient is diseased.

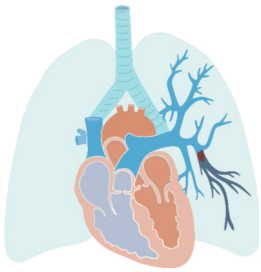


2. If there are two different tests that you can use to diagnose a certain disease, choose the test with the highest specificity.

APPLYING PREDICTIVE VALUES TO REAL-LIFE DIAGNOSES

D-dimer testing





D-dimer testing plays an important role in the diagnosis of venous thromboembolism, such as pulmonary embolism.

One D-dimer assay that is often used in laboratories was evaluated in a study enrolling outpatients with suspected pulmonary embolism. In this study, at the cutoff of 0.5 mg / L, the test had the following specifications.

- A sensitivity of 99%
- A specificity of 43%
- A NPV of 99.3% and
- A PPV of 35%

The high sensitivity of 99% means that 99 out of 100 times a patient with pulmonary embolism will have a positive test result.

The low specificity of 43% means that many patients, who do not have a pulmonary embolism, will have positive D-dimer levels. We call this afalse positive result.

The high negative predictive value of 99% means 99 out of 100 patients, with suspected pulmonary embolism who have D-dimer concentrations lower than 0.5 mg / L, will have no pulmonary embolism.

The low positive predictive value of 35% tells us that a positive D-dimer result is not enough to rule in the diagnosis of pulmonary embolism. We will need other tests to confirm the diagnosis.

Conclusion

In conclusion, we can be confident that we will probably not miss any patients with pulmonary embolism when using this test. However, we can also expect to have lots of false positive results.

The advantage of D-dimer testing lies in **ruling out** pulmonary embolism.

READING LIST

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