

Measurement: Estimates and Trends

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Learning Objectives

- 🌐 List 5 measurements that are important for diabetes management
- 🌐 Define a trend
- 🌐 Explain the difference between accuracy and precision
- 🌐 Name sources of errors in measurement
- 🌐 Define what is "normal"

Why does this matter for diabetes?

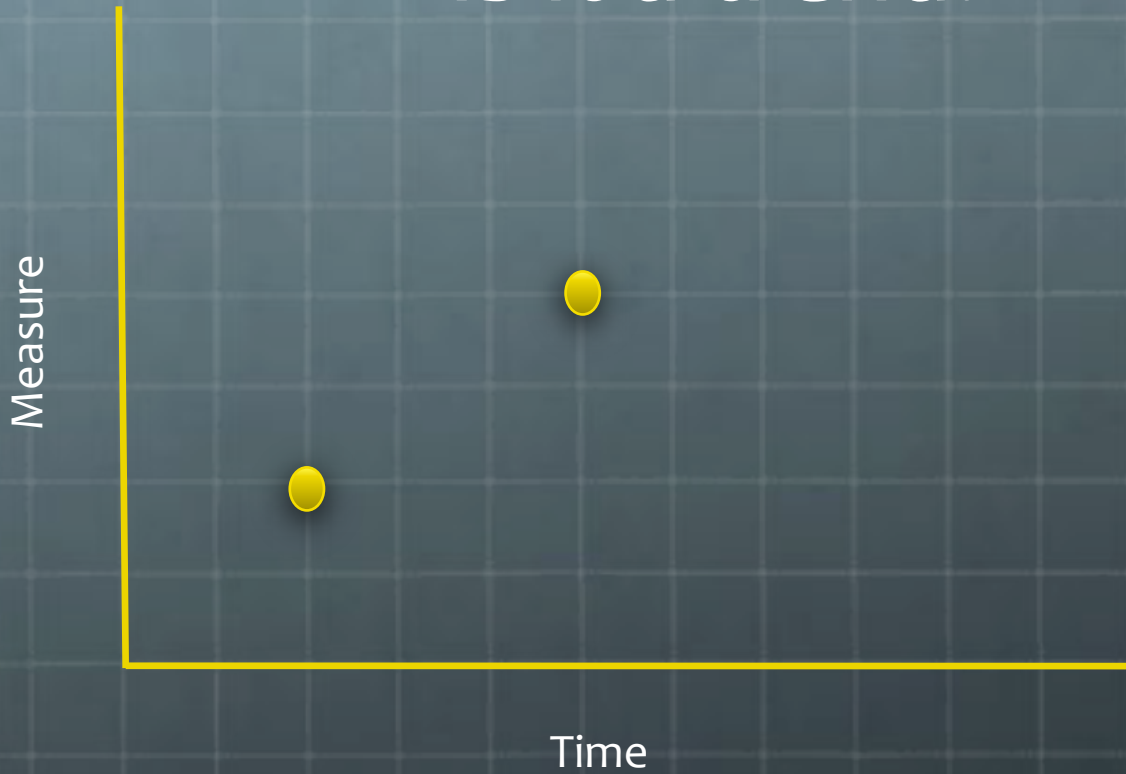
- **DSME national standards emphasize measurement**
 - Interpret and use the results for decisions about self-management
- **DPP curriculum emphasizes measurement**
 - Mainly weight, calories, fat and portion sizes
- **Patients benefit from quantitative thinking**
 - Semi-quantitative reasoning is a close, practical approximation

What do people need to measure?

- 🌐 Weight
- 🌐 Calories and fat
- 🌐 Ingredients
- 🌐 Portion size
- 🌐 Blood glucose
- 🌐 Blood tests
- 🌐 Blood pressure
- 🌐 Activity



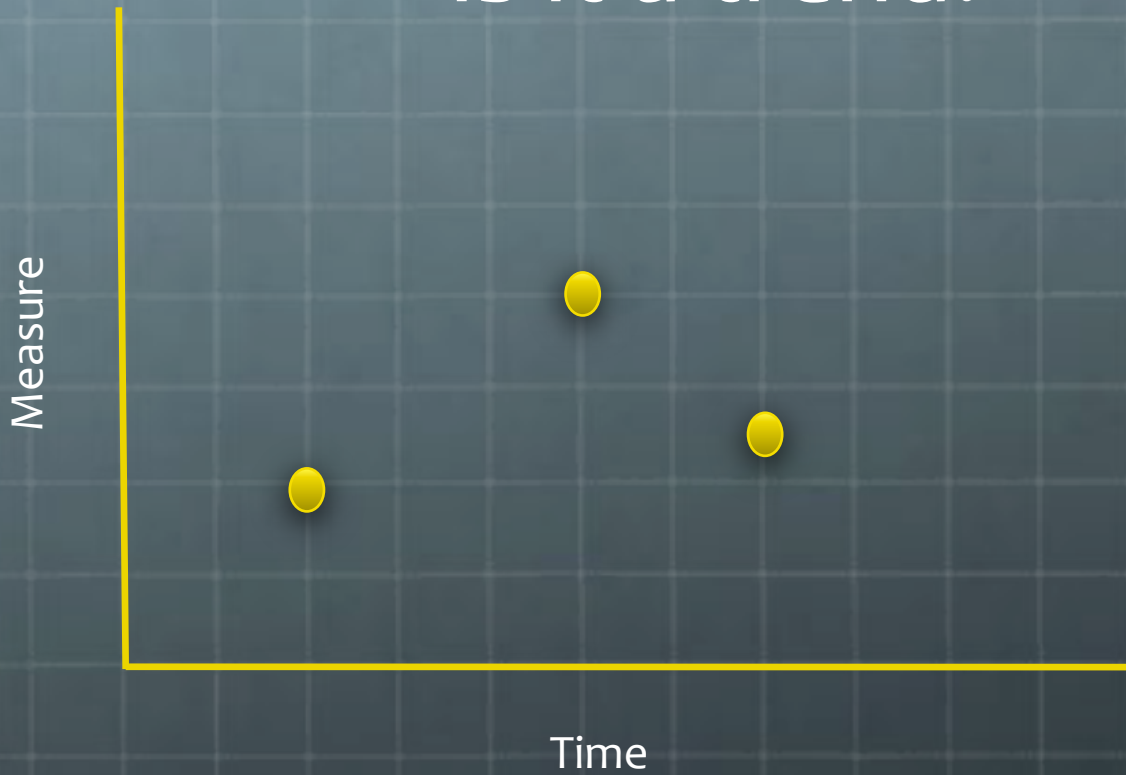
Is it a trend?



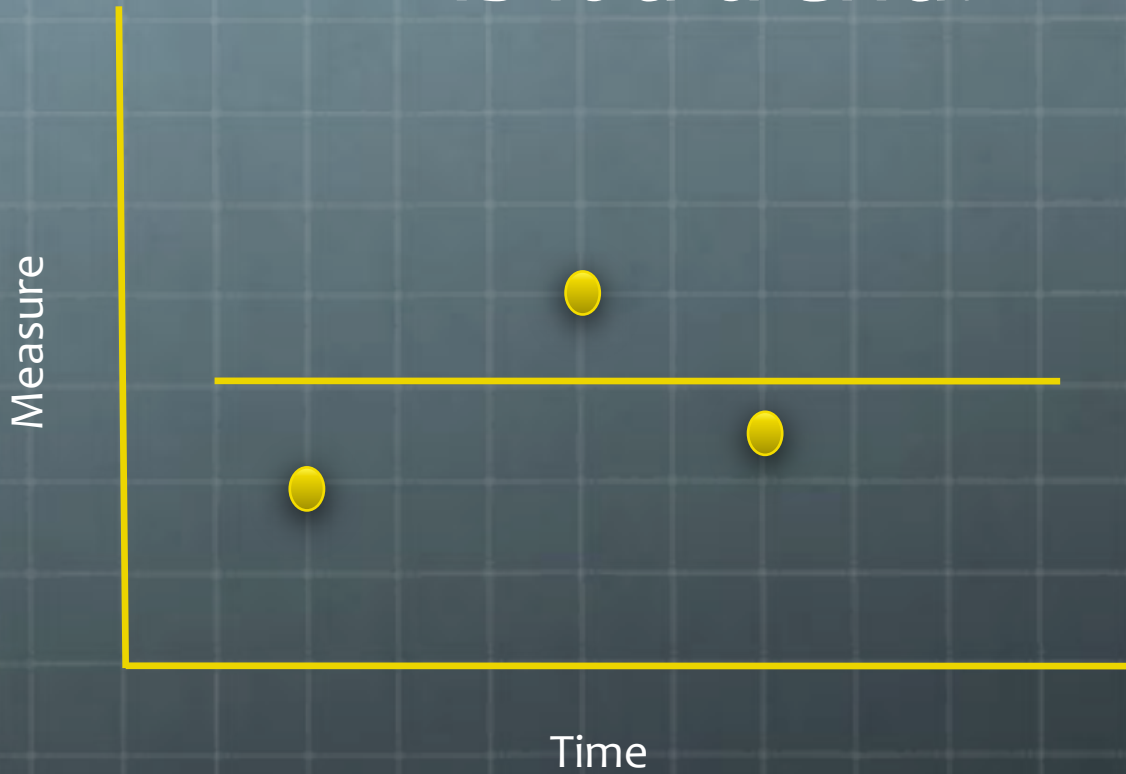
Is it a trend?



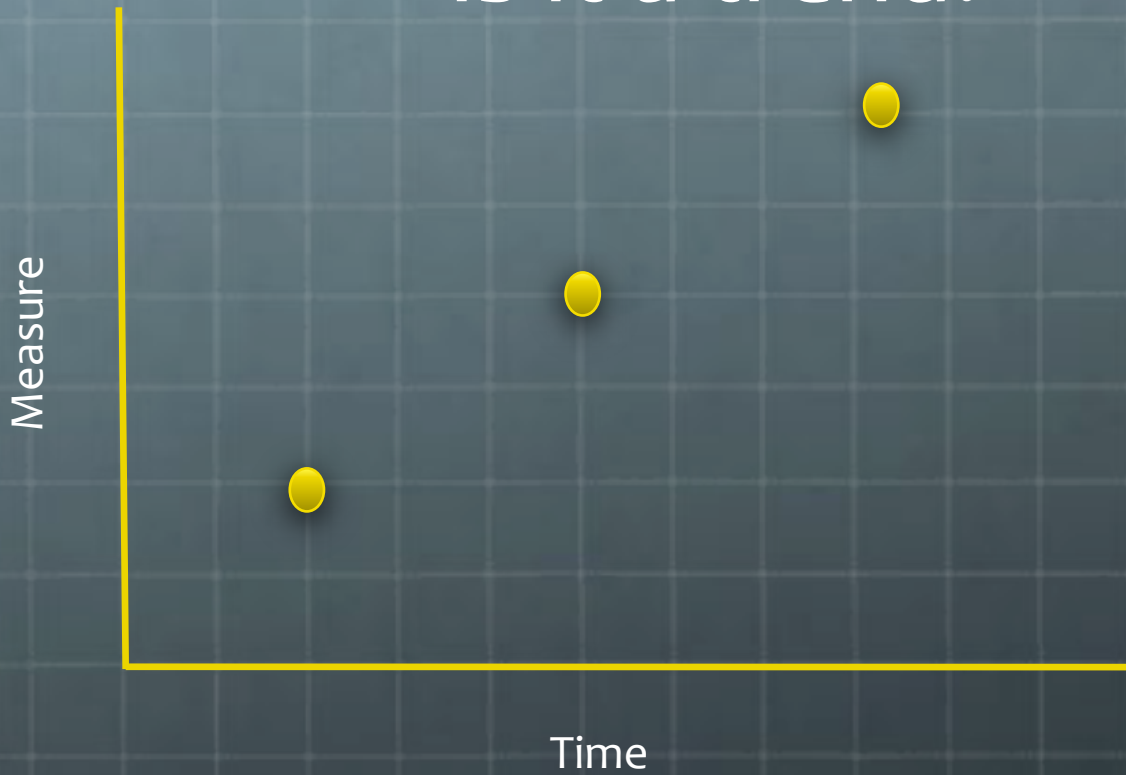
Is it a trend?



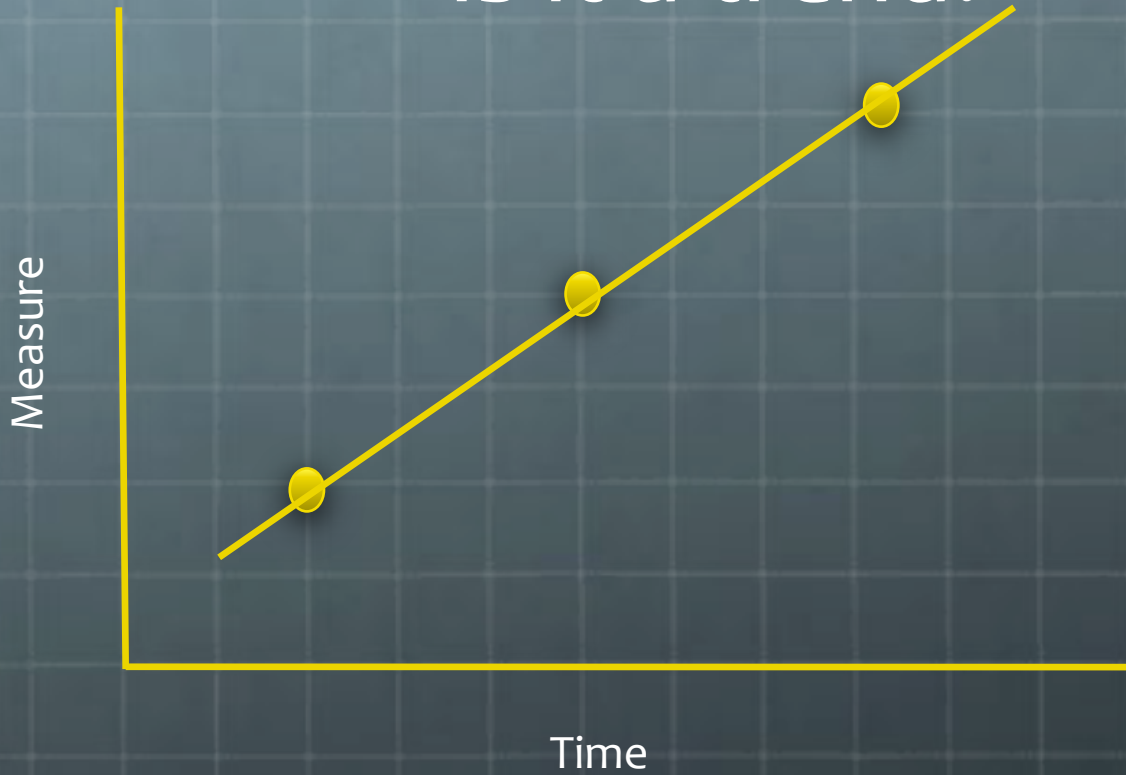
Is it a trend?



Is it a trend?



Is it a trend?



Accuracy vs Precision

Accuracy

- 🌐 Accuracy is how close a measured value is to the actual (true) value.

Precision

- 🌐 Precision is how close the measured values are to each other.

Examples of Accuracy and Precision



High Accuracy
Low Precision



Low Accuracy
High Precision



High Accuracy
High Precision

Accuracy vs Precision

- 🌐 Accuracy of a laboratory test is its correspondence with the true value. Accuracy is maximized by calibrating laboratory equipment with reference material and by participation in external quality control programs.
- 🌐 Precision is a measure of tests reproducibility when repeated on the same sample. An imprecise test is one that yield widely varying results on repeated measurement. The precision is monitored in laboratory by using control material.

Degree of Accuracy

Accuracy depends on the instrument we are measuring with. But as a general rule:

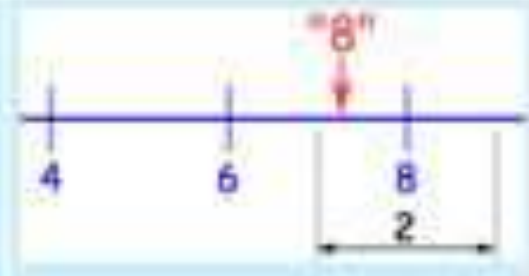
The degree of accuracy is **half a unit** each side of the unit of measure

Examples:

When an instrument measures in "1"s
any value between $6\frac{1}{2}$ and $7\frac{1}{2}$ is measured as "7"



When an instrument measures in "2"s
any value between 7 and 9 is measured as "8"



(Notice that the arrow points to the same spot, but the measured values are different!)

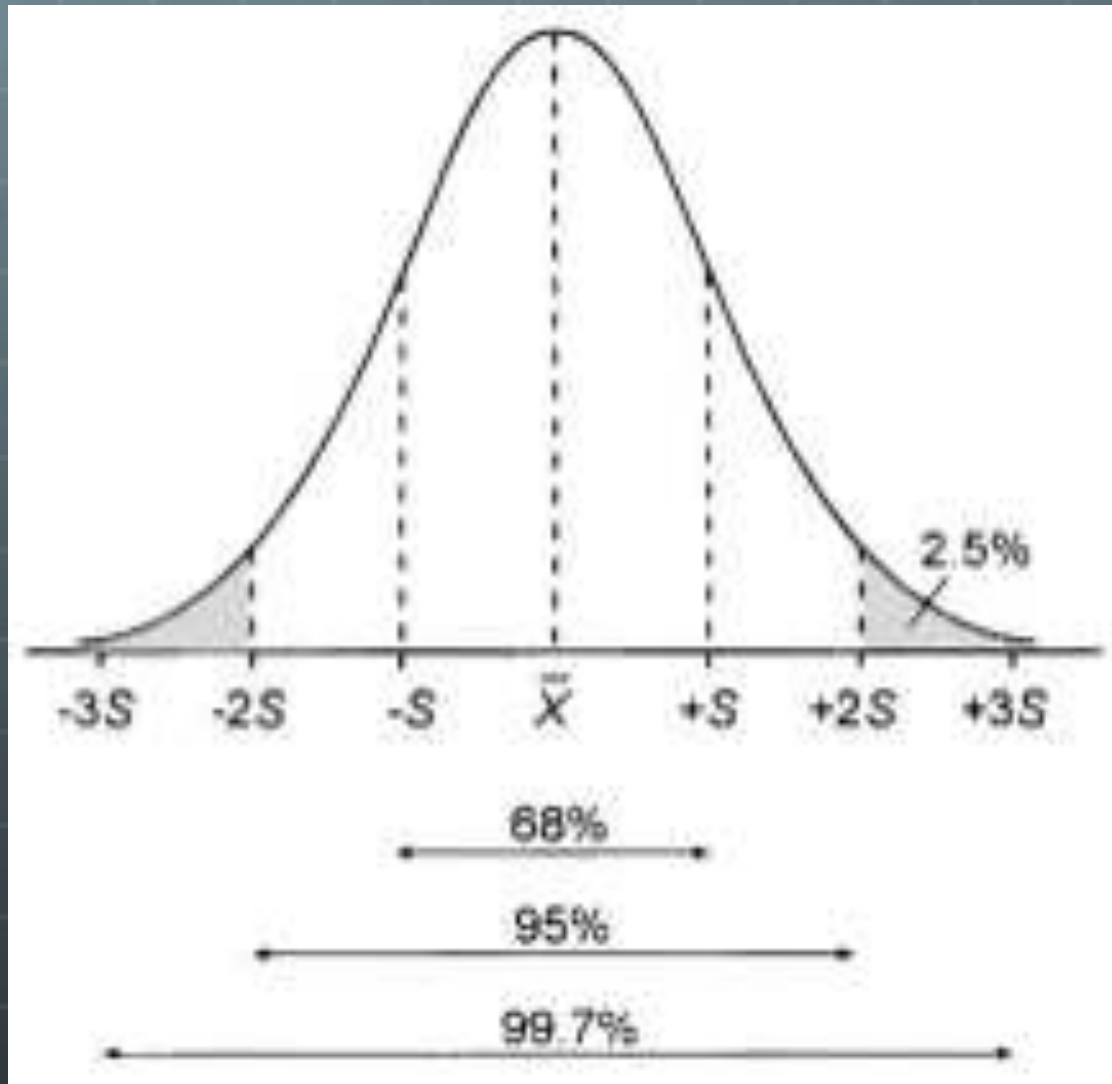
Errors in Measurement

Absolute, Relative and Percentage Errors

- The *Absolute Error* is the difference between the actual and measured value
- The *Relative Error* is the absolute error divided by the actual measurement
- The *Percentage Error* is the Relative Error shown as a percentage

$$\text{Relative error} = \frac{\text{Absolute error}}{\text{Measured value}}$$

What is Normal?



Guidance for Industry and Food and Drug Administration Staff

-  **October 11, 2016**
-  **Blood Glucose Monitoring Test Systems
for Prescription Point Of Care Use**

<https://www.fda.gov/ucm/groups/fdagov-public/@fdagov-meddev-gen/documents/document/ucm380325.pdf>

Clinical Blood Glucose Monitoring Systems (BGMS):

95% of values must be within $\pm 12\%$ for blood sugars below or above 75 mg/dL

98% within $\pm 15\%$

By comparison, the now-outdated rules called for 15% and 20% accuracy across the board. In early 2014, the FDA had proposed tightening the strictest requirement to $\pm 10\%$, but meter manufacturers and clinical healthcare providers objected because it could stop them from either making or obtaining meters affordably. So the regulators met in the middle at 12%.

<https://www.healthline.com/diabetesmine/fda-finalizes-meter-accuracy-rules>

The Plate Method



How much is a gram?

- 🌐 A gram is the weight of 1 milliliter of water
- 🌐 1 teaspoon holds 5 milliliters water
- 🌐 1 Tablespoon is 3 teaspoons, or 15 milliliters water
- 🌐 Salt and oil are denser than water and so need less volume to weigh the same
- 🌐 Remember: 4 calories per gram of CHO and protein;
9 calories per gram of fat

Pre-test Probability

Definition

- 🌐 Pretest Probability is defined as the probability of a patient having the target disorder before a diagnostic test result is known.
- 🌐 It represents the probability that a specific patient, with a specific symptom complex, has a specific diagnosis.

Pre-test Probability Application

The pretest probability is especially useful for four things:

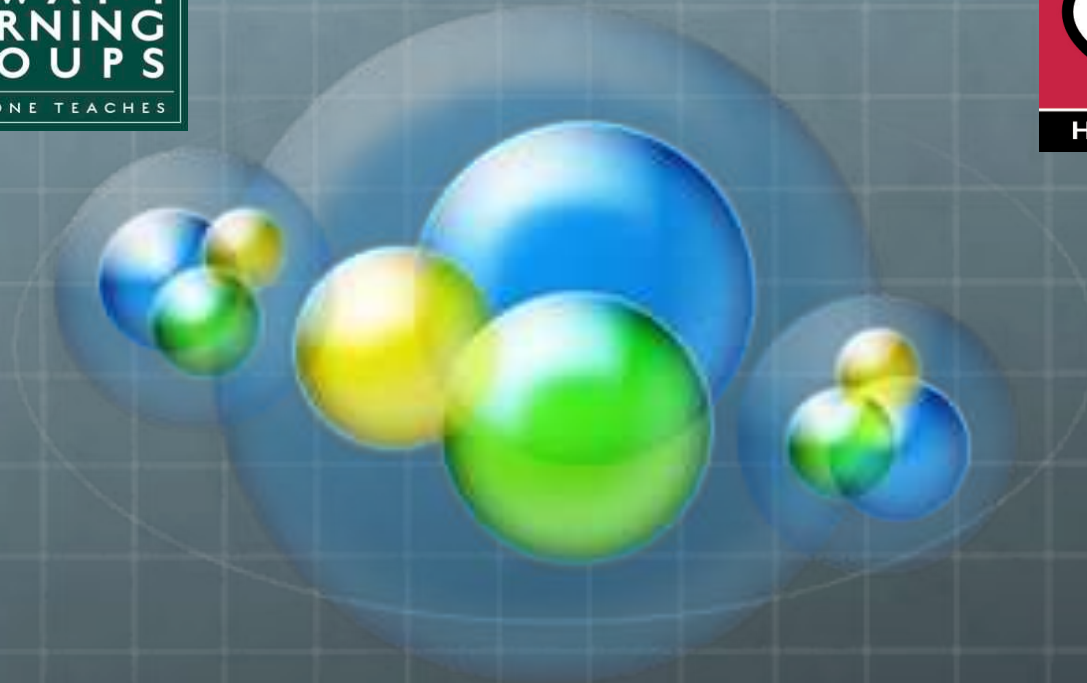
- 1) interpreting the results of a diagnostic test
- 2) selecting one or more diagnostic tests
- 3) choosing whether to start therapy:
 - a) without further testing (treatment threshold)
 - b) while awaiting further testing
- 4) deciding whether it's worth testing at all (test threshold)

Pre-test Probability Calculation

- The probability of the target disorder, usually abbreviated $P(D+)$, can be calculated as the proportion of patients with the target disorder, out of all the patients with the symptoms(s), both those with and without the disorder:

$$P(D+) = D+ / (D+ + D-)$$

- where $D+$ indicates the number of patients with target disorder, $D-$ indicates the number of patients without target disorder, and $P(D+)$ is the probability of the target disorder.



Thank You!
Please discuss...