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Sensitivity and Specificity of Screening Tests

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Sensitivity is the true-positive rate. It measures the proportion of actual positives, which are, correctly, identified. If a person is suffering from a certain disease, and a test, conducted to discover this condition, turns out positive, probability of this right decision may be represented by $(1-\beta)$, which is a measure of sensitivity. β is the probability of wrong decision, when the disease was present, but the relevant test conducted was negative. This is called false negative (missed diagnosis), which may result in denial of essential medical care. Such a situation could have tragic consequences, when early intervention may cure the person or prolong life. A very small β makes the test very sensitive, which has high performance. However, such a test is less reliable. A β close to unity results in many missed diagnoses. Such a test has a high false-negative rate and it is less sensitive. Hence, it generates mistaken perception of acceptability (a safety issue). *Specificity* is the true-negative rate. It measures the proportion of actual negatives, which are, correctly, identified. If a person is not suffering from a certain disease, and a test, conducted to discover this condition, turns out negative, probability of this right decision may be represented by $(1-\alpha)$, which is a measure of specificity. α is the probability of wrong decision, when the disease was not present, but the relevant test conducted was positive. This is called false positive, which may result in over-treatment. Such a situation could cause economic burden and discomfort to patient life. A very small α makes the test highly specific, which is very reliable. However, it has lower performance. An α close to unity results in a high false-positive rate and it is less specific. Hence, it generates mistaken perception of unacceptability (a performance issue). This paper introduced 2 new concepts — *relative sensitivity* and *relative specificity*, in which probabilities of a freshly-introduced test are computed on the basis of agreed-upon standards. The definitions of sensitivity and specificity given in the chart shall become definitions of relative quantities, if disease present (absent) is replaced by positive (negative) result of a clinically-accepted test (agreed-upon standard). In fact, the verdict of a disease present or absent is too big a claim to be given by humans. Results of physical, biochemical and radiological examinations are combined through a suitable clinical model to declare presence of a certain disease. Combined with the definitions of *accuracy* and *precision*, presented earlier by the first author (http://www.ngds-ku.org/Presentations/Physics2.pdf), relative sensitivity and relative specificity should play a leading role in deciding about the suitability of a screening test.

DISEASE ABSENT **TEST OUTCOME** **NEGATIVE** *True Negative* Probability of Right Decision = $1-\alpha$ **SPECIFICITY**	**DISEASE ABSENT** **TEST OUTCOME** **POSITIVE** *False Positive* Probability of Wrong Decision = α **OVER-TREATMENT**
DISEASE PRESENT **TEST OUTCOME** **NEGATIVE** *False Negative* Probability of Wrong Decision = β **MEDICAL CARE DENIAL**	**DISEASE PRESENT** **TEST OUTCOME** **POSITIVE** *True Positive* Probability of Right Decision = $1-\beta$ **SENSITIVTY**

Matrix representing sensitivity and specificity in the context of clinical setting

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