# EVALUATION OF MEDICAL TESTS AND TREATMENT

## PROBABILITIES

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# Probability of more than one event occurring

- The probability that an individual has one OR another mutually exclusive property is the sum of the probabilities of having each individual property. (Man or woman?)
- The probability that an individual has one OR another property not mutually exclusive is the sum of the probabilities of having each individual property minus the probability of having both properties. (Brown eyes or blue eyes or one of each?)

# Probability of more than one event occurring

- The probability that an individual has one AND another property is the product of the individual probabilities. (Smart and pretty?)
- For events whose occurrence is dependent upon the occurrence of an earlier event, probabilities are multiplied together. (Graduated from high school, college, admitted into medical school.)

# Likelihood ratio

- The LIKELIHOOD RATIO is the ratio of the probability of a test result among patients with the target disorder to the probability of that same test result among patients who are free of the target disorder.
- For a POSITIVE result, the Likelihood Ratio is calculated as: [sensitivity/ (1 – specificity)].

  (a/a+d)/(c/c+d)
- For a NEGATIVE result, the Likelihood Ratio is calculated as: [(1 – sensitivity)/ specificity].

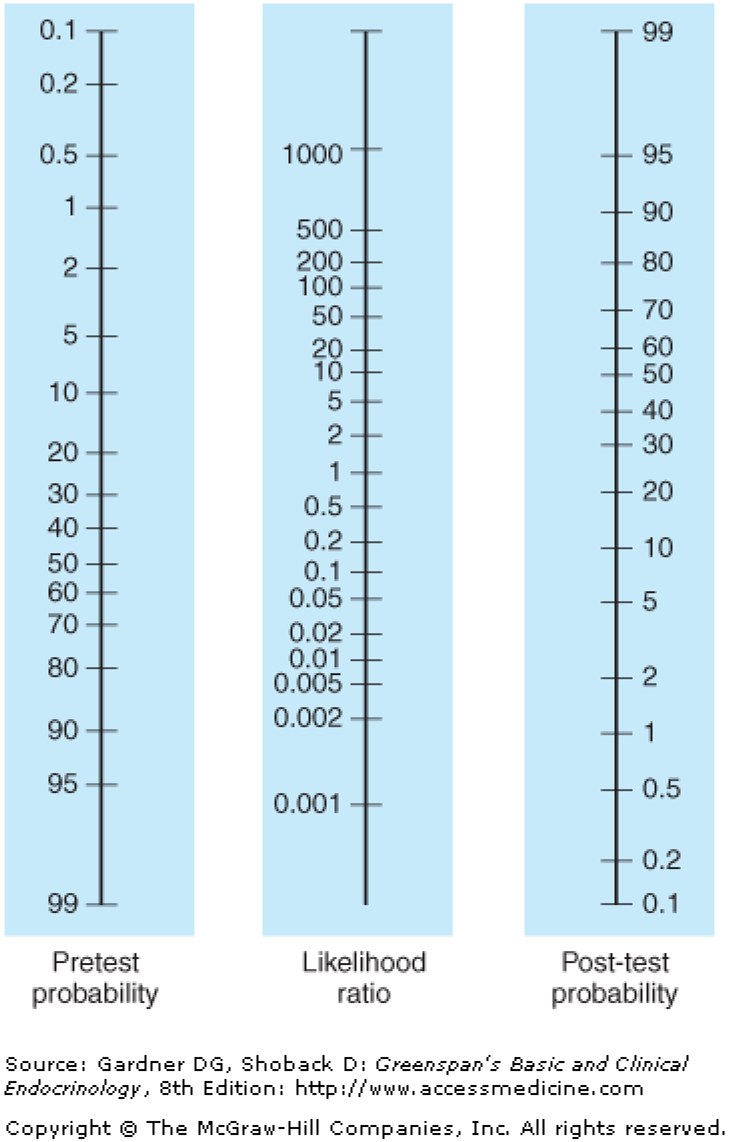
  (b/a+d)/(d/c+d)

# Likelihood ratio

- A high likelihood ratio may not be clinically useful.
- Consider a study reporting the use of D-dimer to distinguish those symptomatic patients with pulmonary embolism from those without pulmonary embolism.
- 2311 symptomatic patients were examined.
- 118 of those patients had confirmed pulmonary embolism.
- The prevalence of disease is 5.1% in this symptomatic group.
- This is 20 times higher than in an asymptomatic population (likelihood ratio >20).

# Likelihood ratio

- 1 of 2193 symptomatic patients without pulmonary embolism had a positive D-dimer assay.
- The negative predictive value of a negative assay is 99%.
- However, only 2 of 118 symptomatic patients with pulmonary embolism were identified by a positive D-dimer assay alone.
- <u>Despite a high likelihood, a positive D-dimer result adds little to the diagnostic strategy</u>.
- A negative result, however, excludes pulmonary embolism.




# Nomogram for likelihood ratios.

(Adapted from Fagan TJ: Nomogram for Bayes theorem. New Engl J Med 1975;293;257. Reprinted, with permission of The New England Journal of Medicine. Copyright 1975, Massachusetts Medical Society.)

Fig. 4-7 Accessed 08/01/2010

# Likelihood ratio

- The pre-test probability of malignancy in a breast lump in a 25 year old woman without a family history of breast or ovarian cancer is 1%.
- The sensitivity of mammography is 70%.
- The specificity of mammography is 40%.
- The post-test likelihood of finding malignancy with mammography alone in a 25yo woman with no family history of breast or ovarian cancer is:

1/100 x 40/(1-0.7)= 1.3/100 or 1.3%.

# Predictive value

| Disease prevalence or pretest probability | 0.1% | 1% | 10% | 50% | 90% |
|---|---|---|---|---|---|
| Positive predictive value | 0.89% | 8.33% | 50.0% | 90.0% | 98.78% |
| Negative predictive value | 99.99% | 99.89% | 98.78% | 90% | 50.0% |

Source: Gardner DG, Shoback D: *Greenspan's Basic and Clinical Endocrinology*, 8th Edition: http://www.accessmedicine.com



Positive and negative predictive values as a function of disease prevalence, assuming test sensitivity and specificity of 90% for each.

Fig. 4-7 Accessed 08/01/2010

# Nomogram for likelihood ratios. Breast cancer.

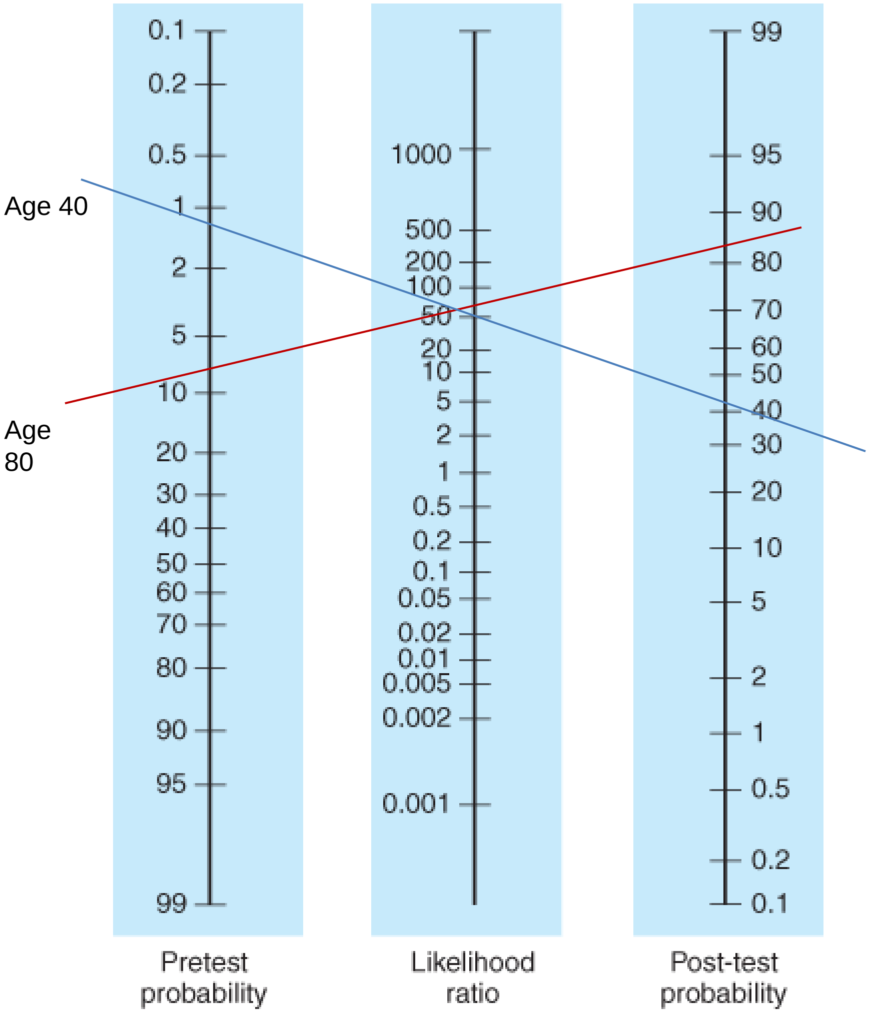



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Fig. 4-7 Accessed 08/01/2010

Modified

# When prevalence changes

- BY THE AGE OF 90
- One of every two men will have suffered from prostate cancer.
- One of every eight women will have suffered from breast cancer.

- BELOW THE AGE OF 50
- The prevalence of either cancer is 1%.

# When prevalence changes

- SCREENING AFTER THE AGE OF 50
- For the entire population of women this translates into a gain of 8 days of life.
- For the affected woman, this translates into a gain of 8 years of life.
- The cost of finding a new breast cancer in women over the age of 50 is $50,000.

# When prevalence changes

- As it has been demonstrated that repeat screening every three years is as effective as yearly screening, the cost of finding a new cancer should be less.
- The rate of false positives rises to as high as 16% in populations rescreened several times over the years.
- Screening is not suggested for those whose life expectancy is less than 10 years.

# When prevalence changes

- SCREENING AFTER THE AGE OF 50
- It has not been demonstrated that the use of PSA screening for prostate cancer is beneficial.
- PSA screening for prostate cancer is not recommended for men over the age of 65 if the initial PSA is less than or equal to 1 ng/ml.
- Screening is not recommended if the life expectancy of the patient is less than 10 years.
- The cost of finding a new prostate cancer is $35,000.

# When prevalence changes

- More women will die of heart disease than will die of breast cancer.

- More men will die of heart disease than will die of prostate cancer.

# Risk ratio

- Relative Risk is the ratio between the rate of the outcome in the treated group and the rate of the outcome in the control group.
- For adverse outcomes, a ratio <1.0 favors the treatment group.
- This is calculated as (a/a+b) / (c/c+d).
- Attributable risk is the difference in risk between exposed and unexposed populations (or the proportion of disease occurrences as a result of exposure).

# Odds ratio

- The Odds ratio is the ratio of the odds of the outcome in a treated (or exposed) group and the odds in the control group.
- This is calculated as a x d / b x c.
- Odds ratio always overestimates relative risk.
- As the baseline probability increases and the relative risk increases, divergence is marked.

# Number needed to treat or harm

- Absolute risk difference is the difference between post-exposure and baseline risk.
- Number needed to treat or harm is the reciprocal of the absolute risk difference.
- If the absolute risk is 0.10, then 10 patients exposed to treatment would yield benefit or harm to 1 patient.

# Number needed to treat or harm

- To calculate the number needed to treat from the relative risk requires the baseline incidence of the complication.
- If the adverse event occurs 1% of the time
- And there is a Relative Risk reduction of 50% (the absolute risk reduction is 0.5%)
- Then the Number Needed to Treat is 1/.005 or 200 patients to see a benefit.

# Number needed to treat or harm (cost)

- To calculate the cost of an intervention, one must have the number needed to treat, the length of time needed to treat in order to see a benefit, and the cost of the intervention.
- If 200 is the number needed to treat, 3 years is the length of time needed to treat in order to see a benefit, and the cost of the intervention is $1/day, then

  200 x 3 x 365 = $21,900