Critical Appraisal

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Critical appraisal

- This process provides clinicians with the means to interpret and determine the applicability of results to their particular patients
- Clinicians should consider multiple explanations for any effect reported in a study which is obtained from:
  - *Quantitative studies*
  - *Qualitative studies*

Critical Appraisal

- The assessment of evidence by systematically reviewing its relevance, validity and results to specific situations.

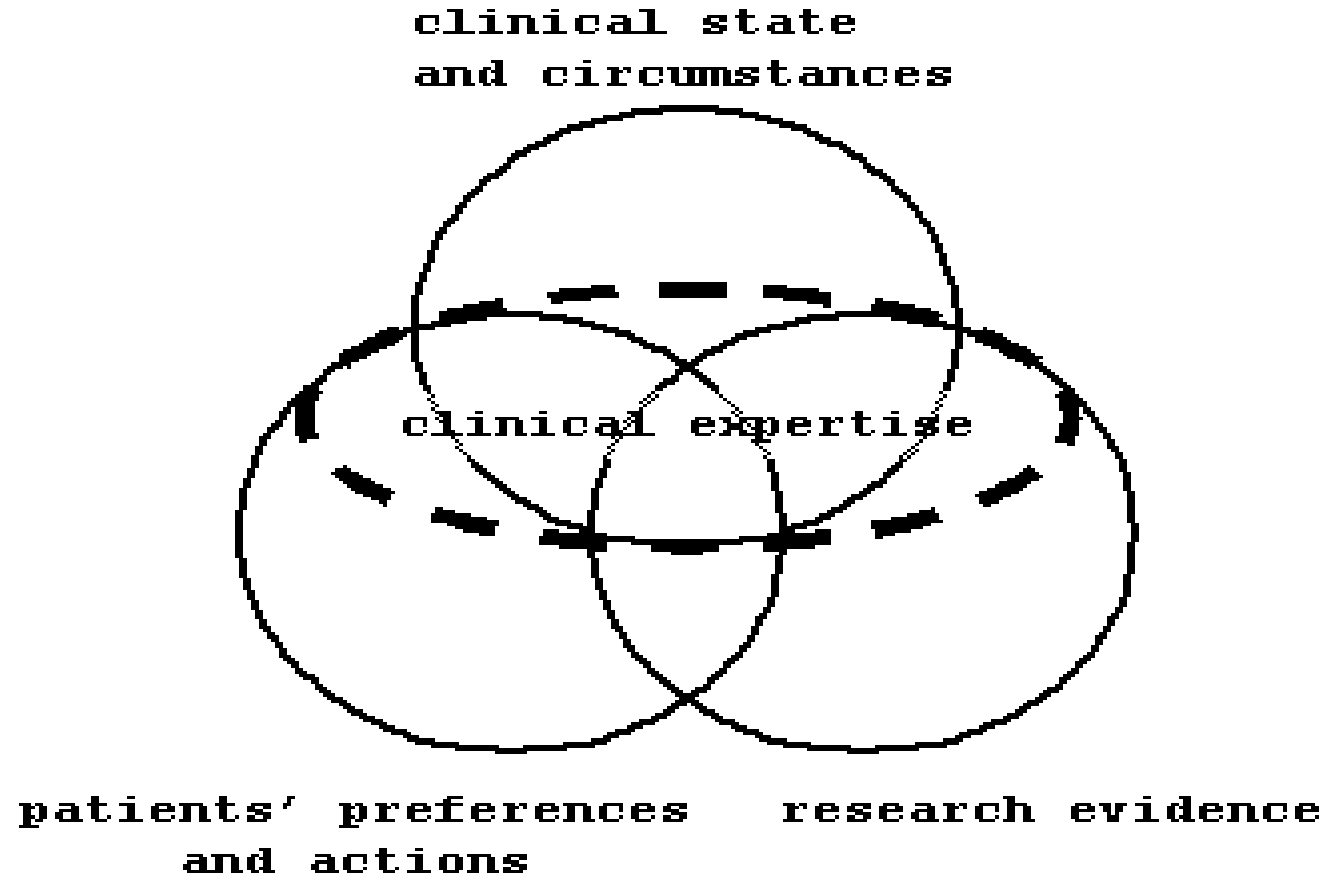
What is ‘best’ evidence?

- Using critical appraisal skills you can understand the methods and results of the research and then be able to assess the quality of the research.

Information Mastery

Slawson and Shaughnessy Formula:

$$\text{Usefulness of Medical Information} = \frac{\text{Relevance x Validity}}{\text{Work to Access}}$$



Basic elements of clinical decision making

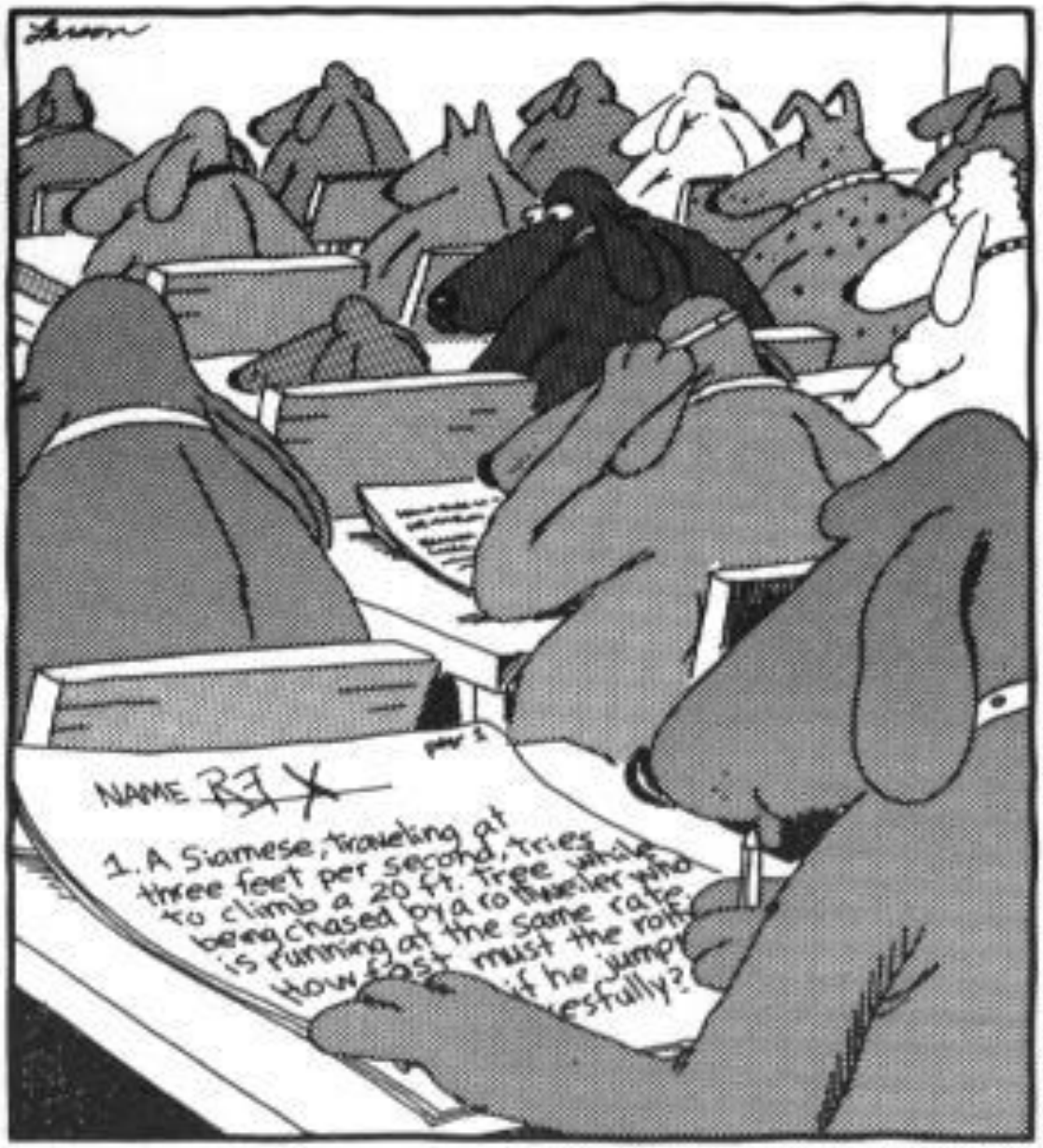
Haynes RB. Loose connections between peer-reviewed clinical journals and clinical practice. Ann Intern Med 1990;113:724-8.

Why Critical Appraise?

Published research is not always reliable

Published research is not always relevant

To improve clinical effectiveness, we need a systematic framework to interpret research



Before their admission to any canine university, dogs must first do well on the CATs.

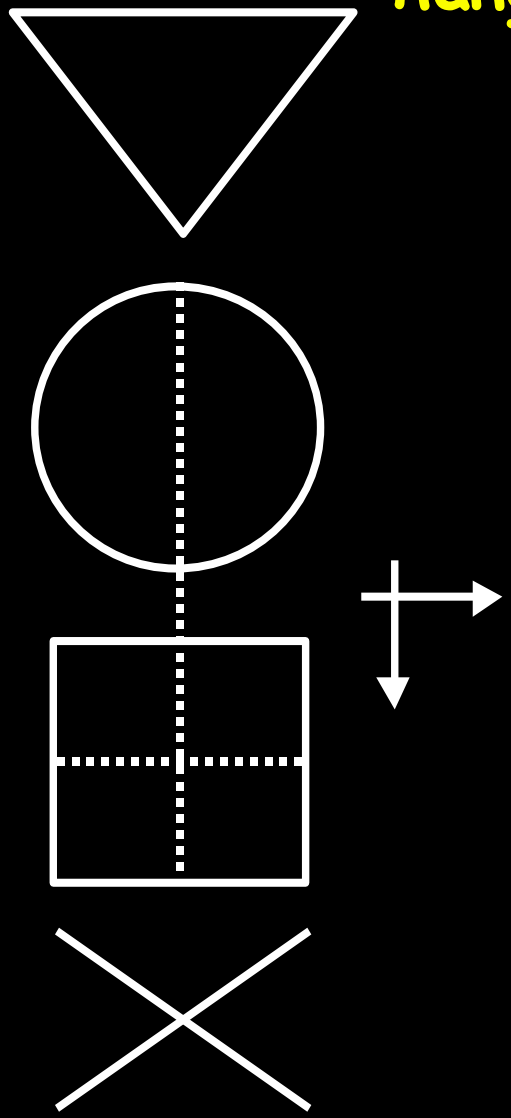
CATs:

Critically Appraised Topics:

'a tool for modeling the steps of EBP'

www.epiq.co.nz

The GATE Approach: every epidemiological study hangs on the GATE frame

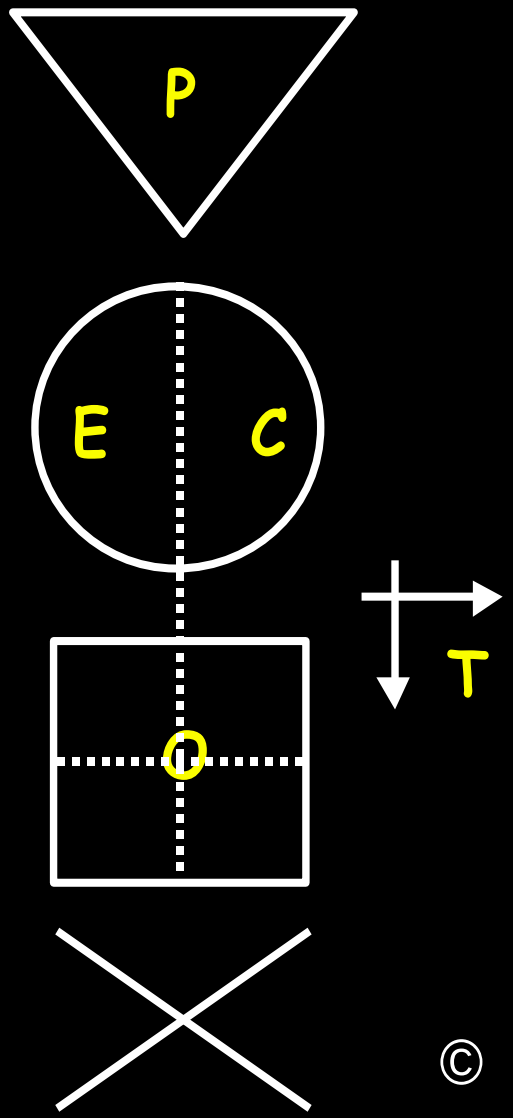


there is only one study design:

- RCT - interventions
- Cohort studies - prognosis / interv./ aetiology
- Cross-sectional studies - diagnosis
- Case-control studies - interv./aetiol.

GATE: Graphic Appraisal Tool for Epidemiology

GATE Frame: PECOT



- Population
- Exposure
- Comparison
- Outcome
- Time

GATE: Graphic Appraisal Tool for Epidemiology

Difficulties with Critical Appraisal

- Can be time consuming initially
- Doesn't provide an "easy" answer
- It could show a lack of good evidence in a particular topic

Key Steps to Effective Critical Appraisal

1. Are the results valid?
2. What are the results?
3. How will these results be relevant to the patient?

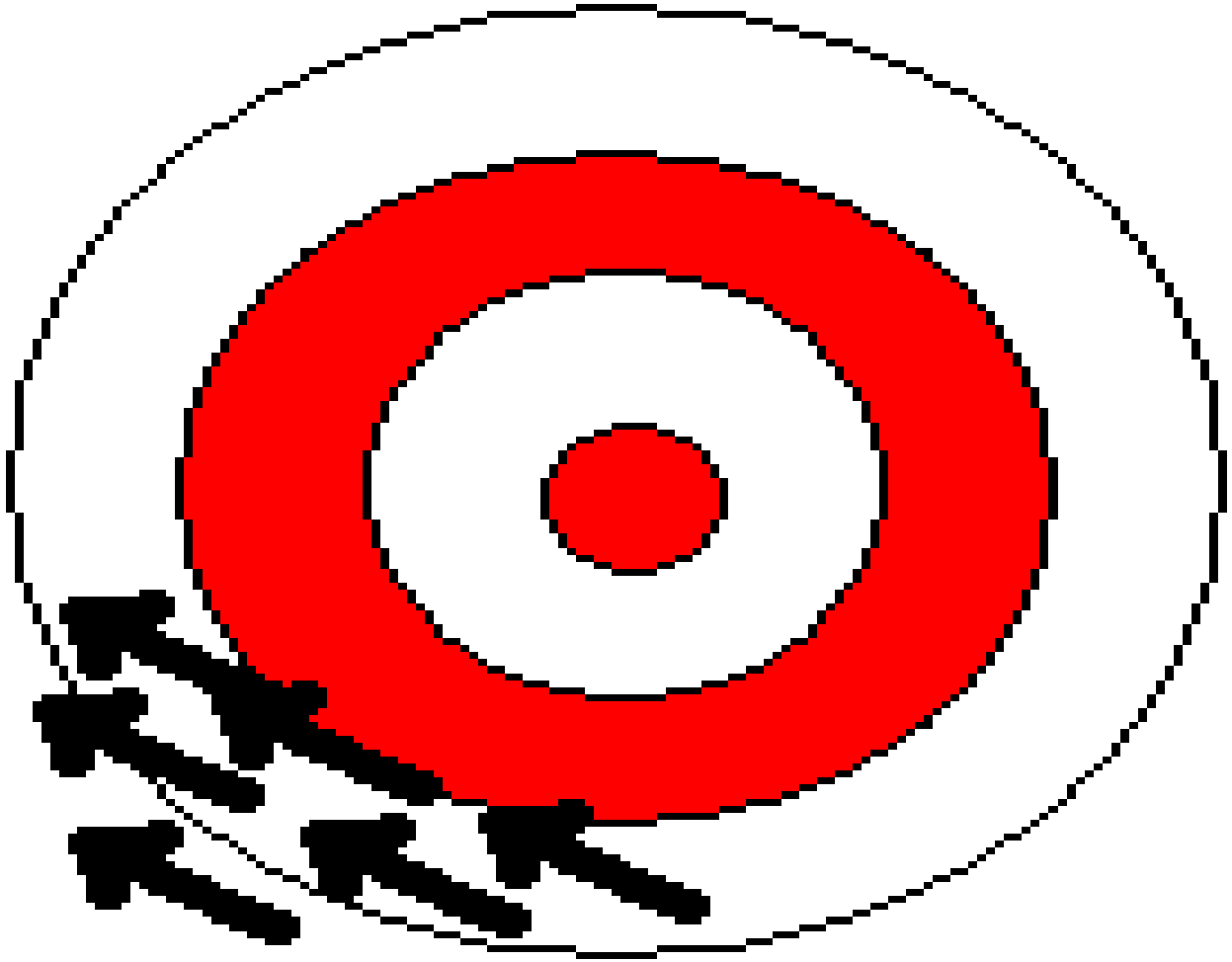
Validity

- A test is valid when it measures what it's supposed to.
- If a test is reliable, it yields consistent results.
- A test can be both reliable and valid, one or the other, or neither.

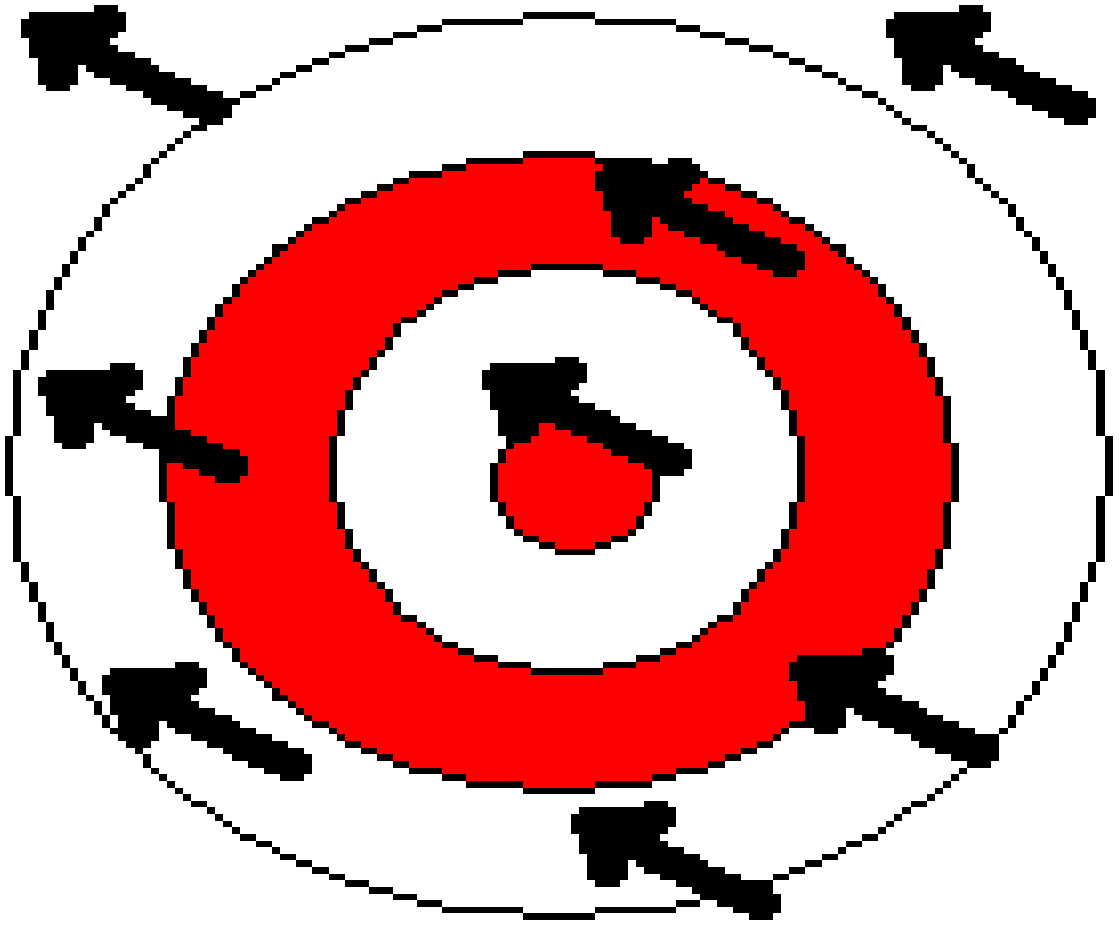
Reliability

a prerequisite for measurement validity

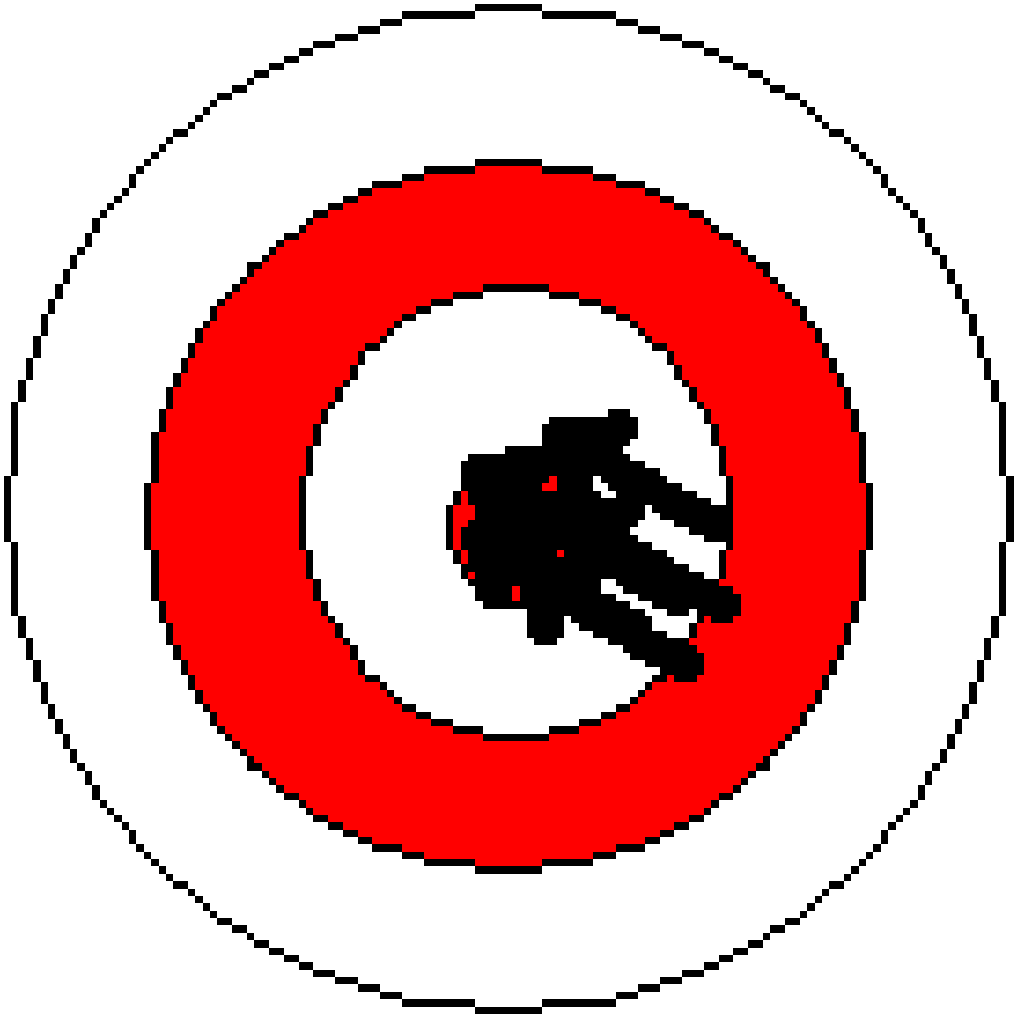
Reliable, but Not Valid!



Not Reliable, Not Valid!



Reliable and Valid



Questions in critical appraisal

- **Validity:**
  - Bias (reference pop., non-homogenous sample, sample selection, measurements, contamination, study attrition or drop-out rate)
  - Confounding variables

Reliability

- Size of the effect
- Precision of the effect
- Magnitude of the effect (i.e. prevalence, incidence)
- Effect measures (e.g. risk, odds) and its precision
- Strength of the association (e.g. RRR, NNT)
- Measures of clinical significance
- Power (accuracy and representativeness of the results, i.e. type I and II errors or α and β error)
- Sensitivity and specificity

Applicability

- Will the results help locally?

Type of articles

- Diagnosis
- Etiology/harm
- Prognosis
- Therapy

مطالعات تشخيصي

- پزشكان به نحوي فرآيند دستور انجام آزمايشهاي تشخيصي و غربالگري را صادر مي كنند و استفاده كنندگان از خدمات بهداشتي هم همواره انتظار انجام اين آزمايشها را دارند. اما آزمايش ها هرگز ۱۰۰% دقيق نيستند و نتيجه " مثبت كاذب" و " منفي كاذب" متضمن حالت ابتلاي خود هستند.
- هدف اين بخش ايجاد توانايي در ارزيابي يك مطالعه مربوط به تعيين عملكرد آزمايش تشخيصي يا غربالگري نسبت به يك معيار اساسي
- (استاندارد طلايي Gold Standard)
- مشخص نشان بدهند و در مفيد بودن علمي آن تصميم بگيرند شركت كنندگان بايد احساس اطمينان كنند كه مي توانند به ديگران هم كمك كنند تا اين توانايي را نشان بدهند.
- مطالعاتي كه صحت آزمونهاي تشخيصي را بررسي مي كنند ممكن است از نوع مقطعي يا مورد شاهدي باشند.

- در حالي كه مطالعاتي كه صحت آزمونهاي پيش بيني كننده وضعيت بيماري را ارزيابي مي كنند، معمولاًاز نوع هم گروهي هستند. البته مطالعات مورد – شاهدي در ارزيابي صحت آزمون هاي تشخيصي محدود به بيماريهاي نادر مي شود كه هيچ طرح مطالعه ديگري براي آنها نمي توان انجام داد يا انجام آن بسيار دشوار است.

در تعيين صحت آزمايش يا روش تشخيصي دو نكته را بايد در نظر گرفت

- ميزان كارآيي روش تشخيصي در وضعيت مورد نظر چقدر است؟ (چند درصد از بيماراني كه داراي نتيجه آزمايش مثبت هستند ،واقعاً مبتلا به بيماري هستند؟) (حساسيت = ميزان مثبت واقعي)

- ميزان شناسايي صحيح آن دسته از افرادي است كه به بيماري مورد نظر مبتلا نيستند چقدر است؟ (ويژگي = ميزان منفي واقعي)

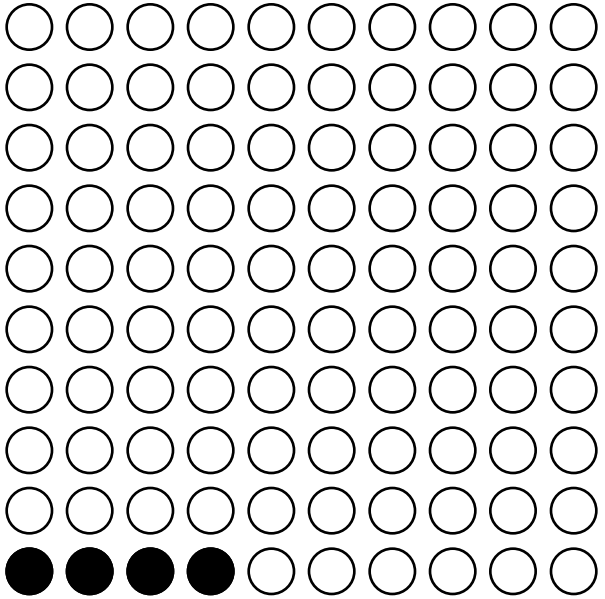
- علاوه بر حساسيت و ويژگي ،دو ميزان ديگر در تعيين اعتبار يك آزمون تشخيصي اهميت دارند حساسيت ويژگي را مي توان بطور مستقل با مطالعه جداگانه گروههاي افراد بيمار و سالم تعيين نمود. با وجود اين مفيد بودن يك آزمون تشخيصي به ميزان **شيوع** حقيقي بيماري مورد نظر در جمعيت مورد مطالعه نيز بستگي دارد.
- ارزش (مقدار) پيش بيني يك آزمون پارامتر مهمتري است. مقدار پيش بيني يك آزمون نسبت موارد واقعي در ميان كل افرادي است كه نتيجه آزمون در آنها مثبت است .
- ميزان شيوع حقيقي بيماري با مقدار پيش بيني يك آزمون به ازاي هر مقدار حساسيت و ويژگي ارتباط مستقيم دارد ،

- با افزايش شيوع بيماري "مقدار پيش بيني " افزايش مي يابد .
- براي مثال ، يك آزمون در يك محيط بيمارستاني كه انتظار مي رود شيوع هر وضعيت زياد باشد، مقدار پيش بيني زيادي خواهد داشت ،در حاليكه وقتي همين آزمون براي جمعيت عمومي بكار مي رود مقدار پيش بيني (Predictive value) كمي داشته باشد كه عملاً كارايي نخواهد داشت.

- "مقدار پيش بيني " = "ارزش اخباري"

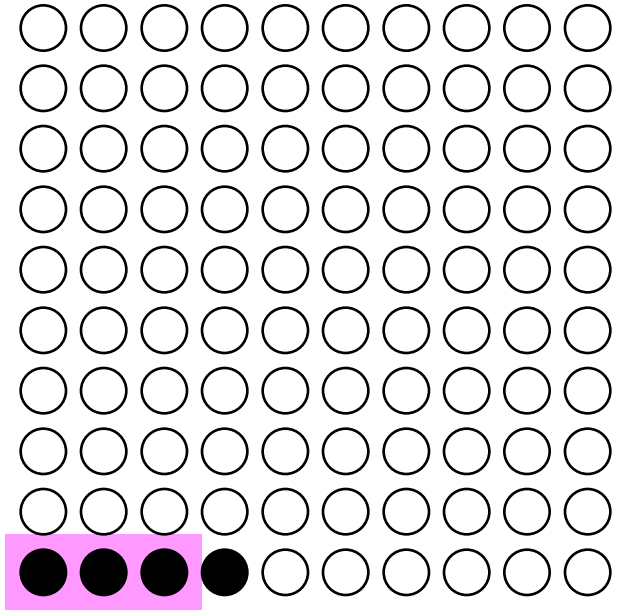
Person without the disease	○
Person with the disease	●

Assume that the prevalence of the disease is 4%



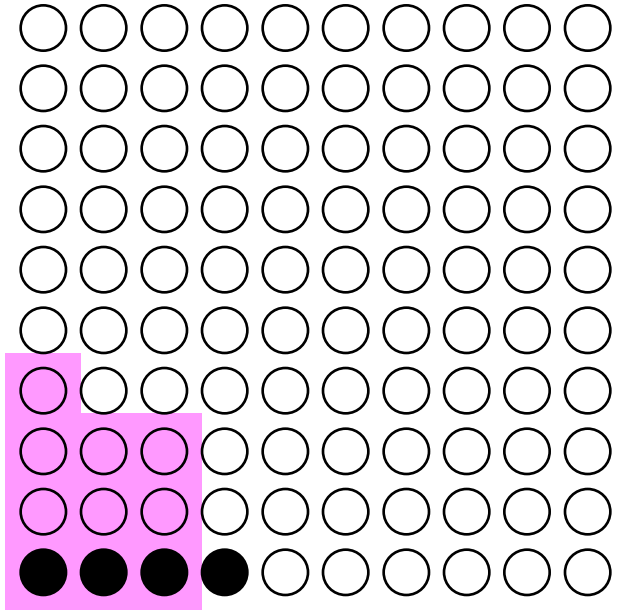
Assume that of the 4 people with the disease, 3 are picked up by the test

Person without the disease	○
Person with the disease	●
Person who tests positive	
Person who tests negative	



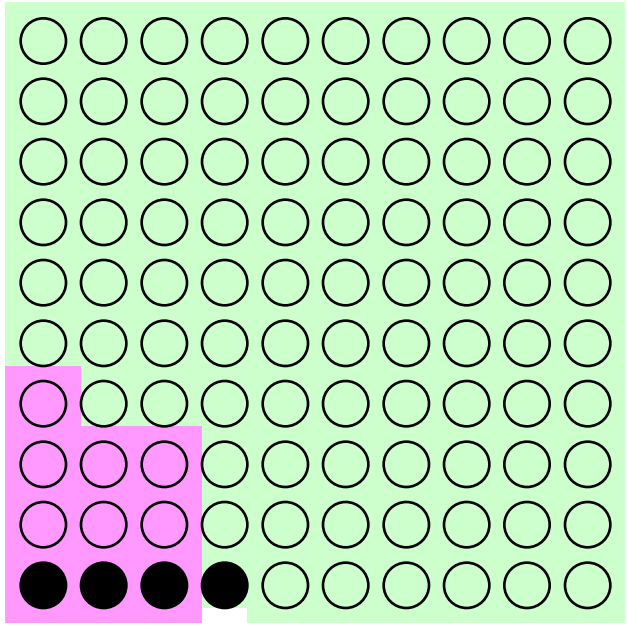
Assume that of the test is positive for a further 7 people who don't have the disease

Person without the disease	○
Person with the disease	●
Person who tests positive	▭
Person who tests negative	▭
True positive on the test	●
False positive on the test	○



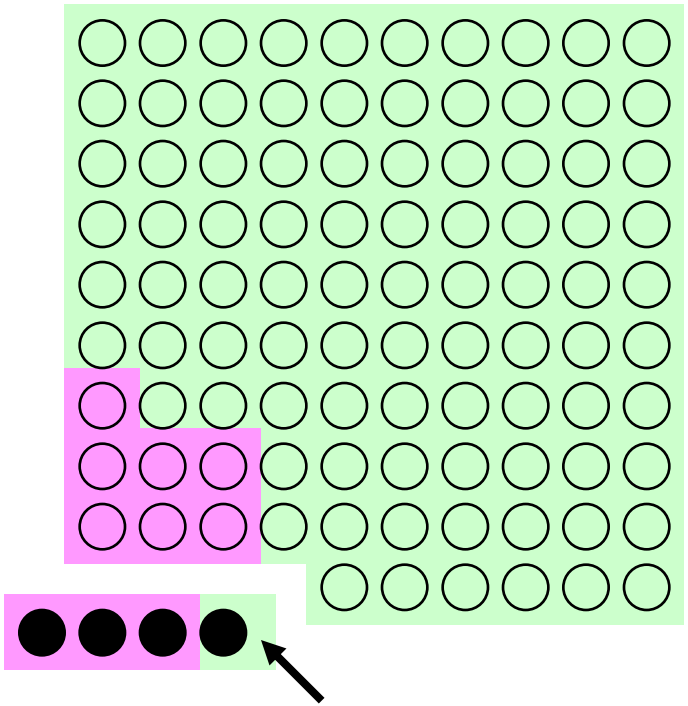
The remainder of the sample are negative on the test

Person without the disease	
Person with the disease	
Person who tests positive	
Person who tests negative	
True positive on the test	
False positive on the test	
True negative on the test	
False negative on the test	



SENSITIVITY

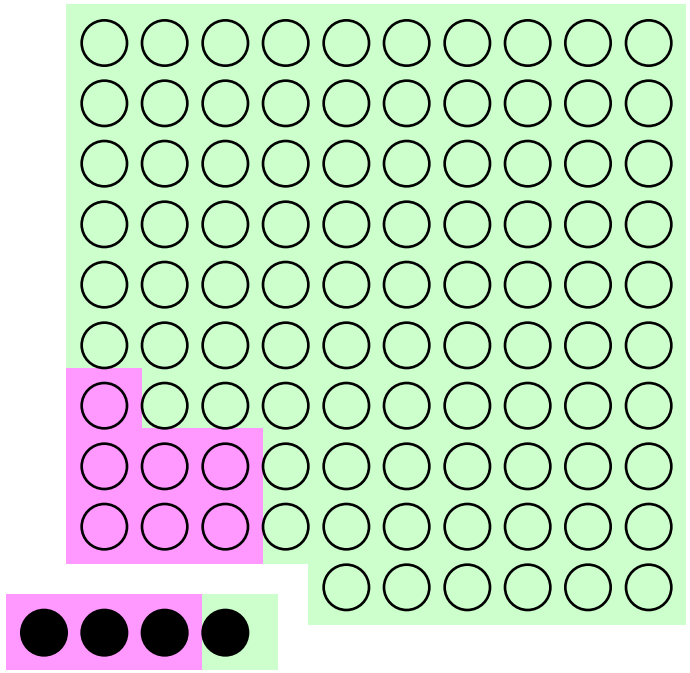
Person without the disease	○
Person with the disease	●
Person who tests positive	
Person who tests negative	
True positive on the test	●
False positive on the test	○
True negative on the test	○
False negative on the test	●



- **SENSITIVITY is the proportion of people with the disease correctly identified by the test**
- **It measures the proportion of false NEGATIVES**

SENSITIVITY

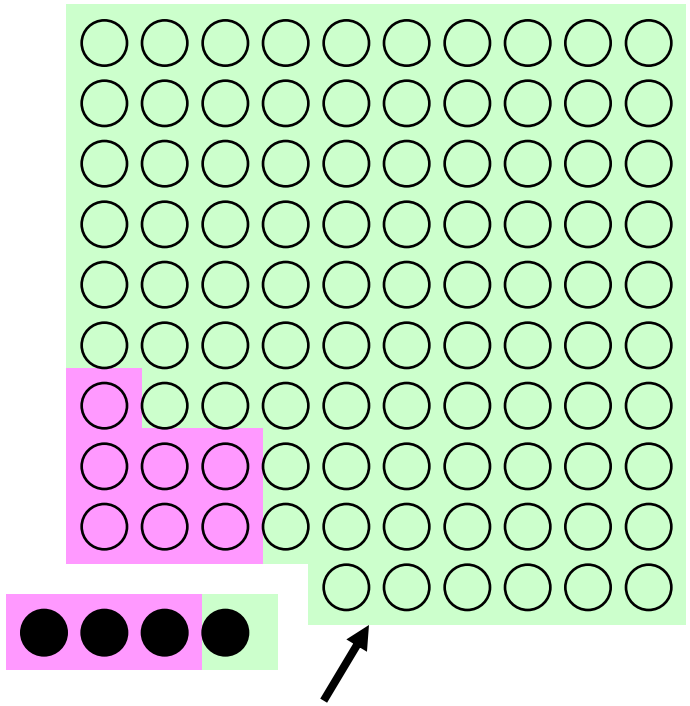
Person without the disease	○
Person with the disease	●
Person who tests positive	
Person who tests negative	
True positive on the test	●
False positive on the test	○
True negative on the test	○
False negative on the test	●



In this case, sensitivity is ¾ or 75%

SPECIFICITY

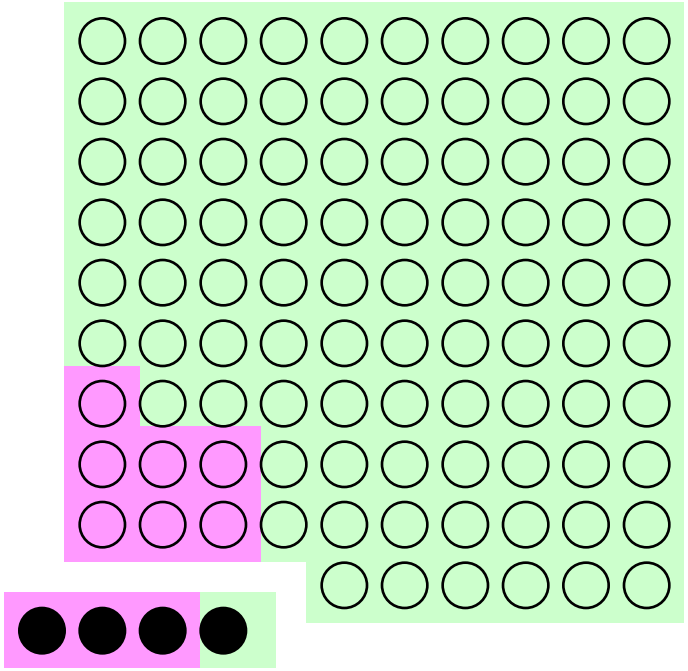
Person without the disease	○
Person with the disease	●
Person who tests positive	▭
Person who tests negative	▭
True positive on the test	●
False positive on the test	○
True negative on the test	○
False negative on the test	●



- **SPECIFICITY is the proportion of people without the disease correctly identified by the test**
- **It measures the proportion of false POSITIVES**

SPECIFICITY

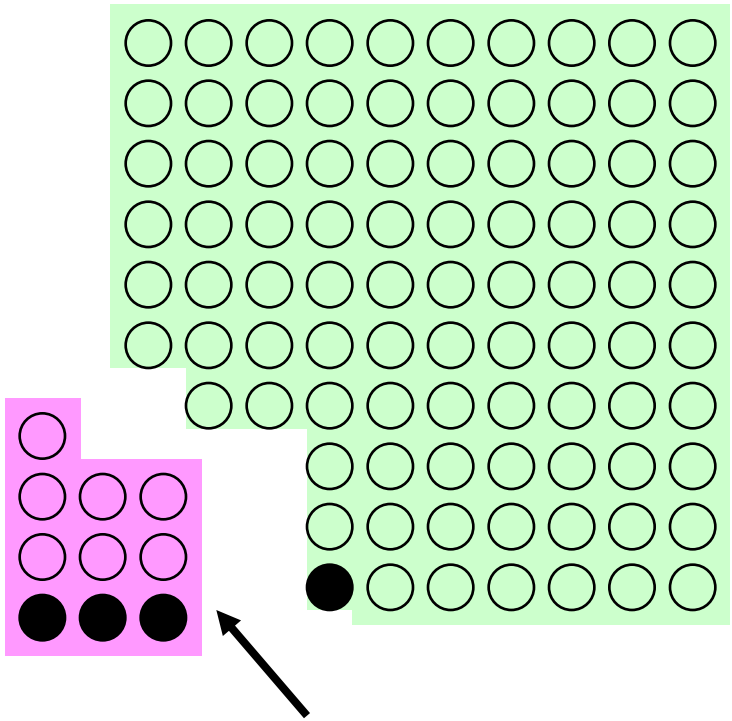
Person without the disease	○
Person with the disease	●
Person who tests positive	
Person who tests negative	
True positive on the test	●
False positive on the test	○
True negative on the test	○
False negative on the test	●



In this case, specificity is (96-7)/96 or 93%

If someone is positive on the test, what are the chances that he/she has the disease?

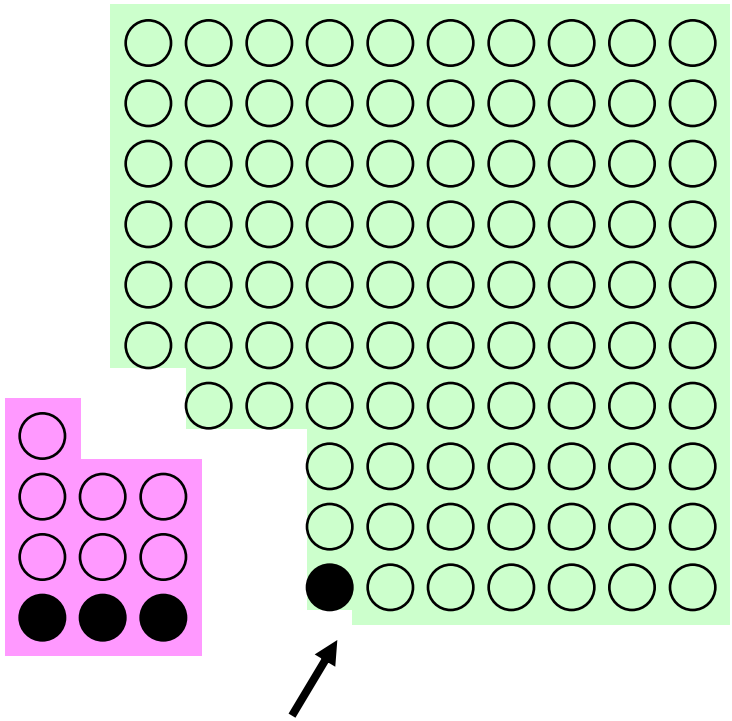
Person without the disease	
Person with the disease	
Person who tests positive	
Person who tests negative	
True positive on the test	
False positive on the test	
True negative on the test	
False negative on the test	



- **Probability = 3/10 = 30%**
- **This is the POSITIVE PREDICTIVE VALUE (the value of the test in predicting a positive result)**

If someone is negative on the test, what are the chances that he/she does not have the disease?

Person without the disease	○
Person with the disease	●
Person who tests positive	▭
Person who tests negative	▭
True positive on the test	●
False positive on the test	○
True negative on the test	○
False negative on the test	●



- **Probability = 89/90 = 99%**
- **This is the NEGATIVE PREDICTIVE VALUE (the value of the test in predicting a negative result)**

Diagnosis

Validity:

- What is the **defined** question?
- How could be compared with **gold standard**?
- How about **Spectrum**?
- Application for **all patients**?

Diagnosis

Reliability:

- **Sensitivity**
- **Specificity**
- **Positive/Negative predictive value (PPV/NPV)**
- **Positive/Negative likelihood ratio**
- **Prevalence**

Definition

- **Sensitivity** is the probability of a positive test in a diseased person
- **Specificity** is the probability of a negative test in a non-diseased person
- **POSITIVE PREDICTIVE VALUE (PPV)** is the value of the test in predicting a positive result
- **NEGATIVE PREDICTIVE VALUE (NPV)** is the value of the test in predicting a negative result

Sensitivity: % patients with disease and positive test

Specificity: % people without disease and with negative test

PPV: % people with positive test who are really diseased

NPV: % people with negative test who are really healthy

		Target	disorder	total
		+	-	
Diagnostic	+	A	B	A+B
test result	-	C	D	C+D
total		A+C	B+D	A+B+C+D

Sensitivity = a/(a+c)
Positive Predictive Value = a/(a+b)

Specificity = d/(b+d)
Negative Predictive Value = d/(c+d)

- Pre-test probability (prevalence) = (a+c)/(a+b+c+d)
- Pre-test odds = prevalence/(1-prevalence)
- Post-test odds = pre-test odds ´ LR
- Post-test probability= post-test odds/(post-test odds +1)

- Likelihood ratio for a positive test result :

  LR(+) = sensitivity/(1-specificity)

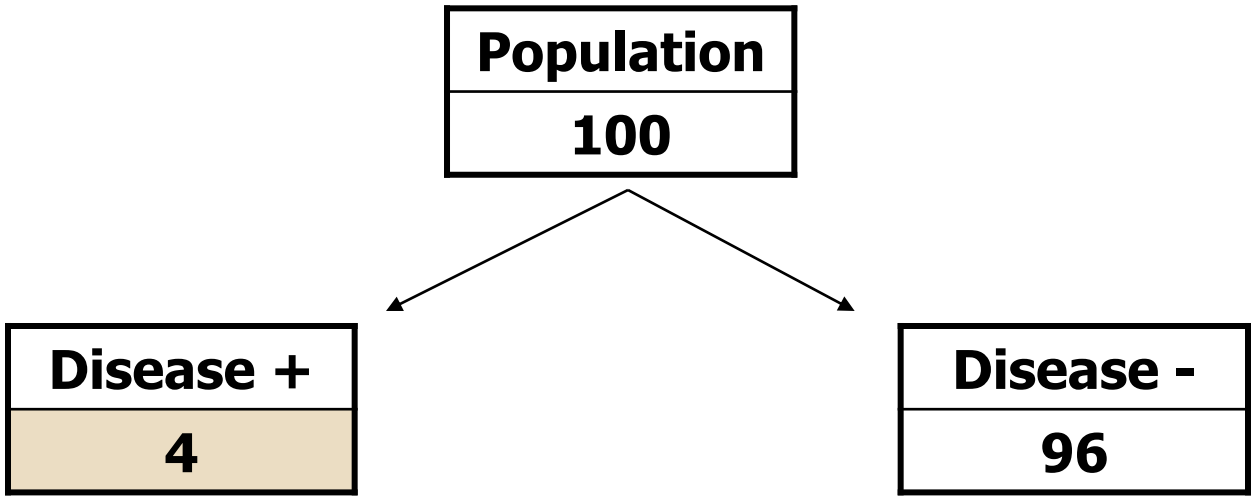
- Likelihood ratio for a negative test result :

  LR(-) = (1-sensitivity)/specificity

NATURAL FREQUENCIES TREE

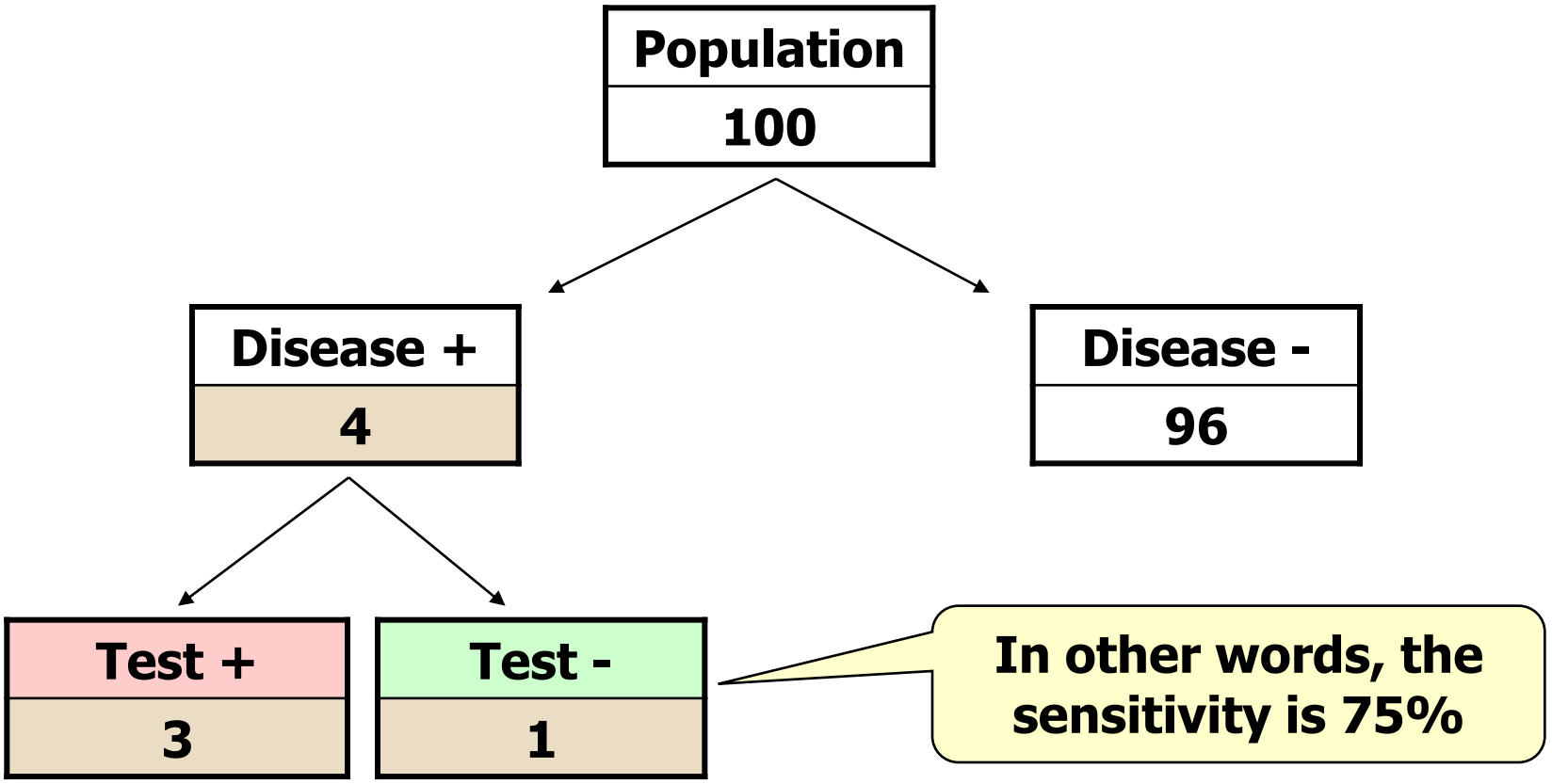
Population
100

IN EVERY 100 PEOPLE, 4 WILL HAVE THE DISEASE

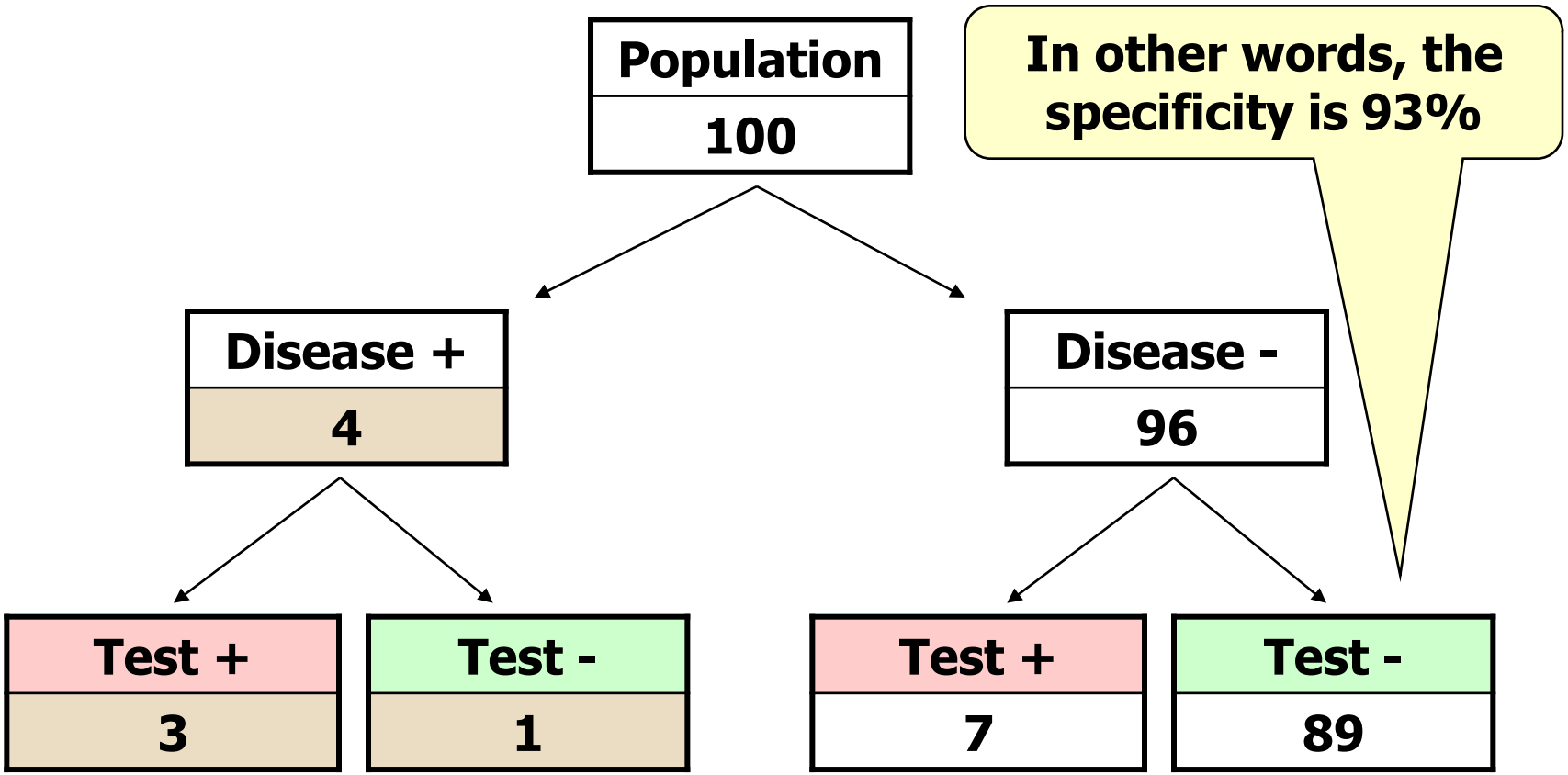


If these 100 people are representative of the population at risk, the assessed rate of those with the disease (4%) represents the PREVALENCE of the disease – it can also be considered the PRE-TEST PROBABILITY of having the disease

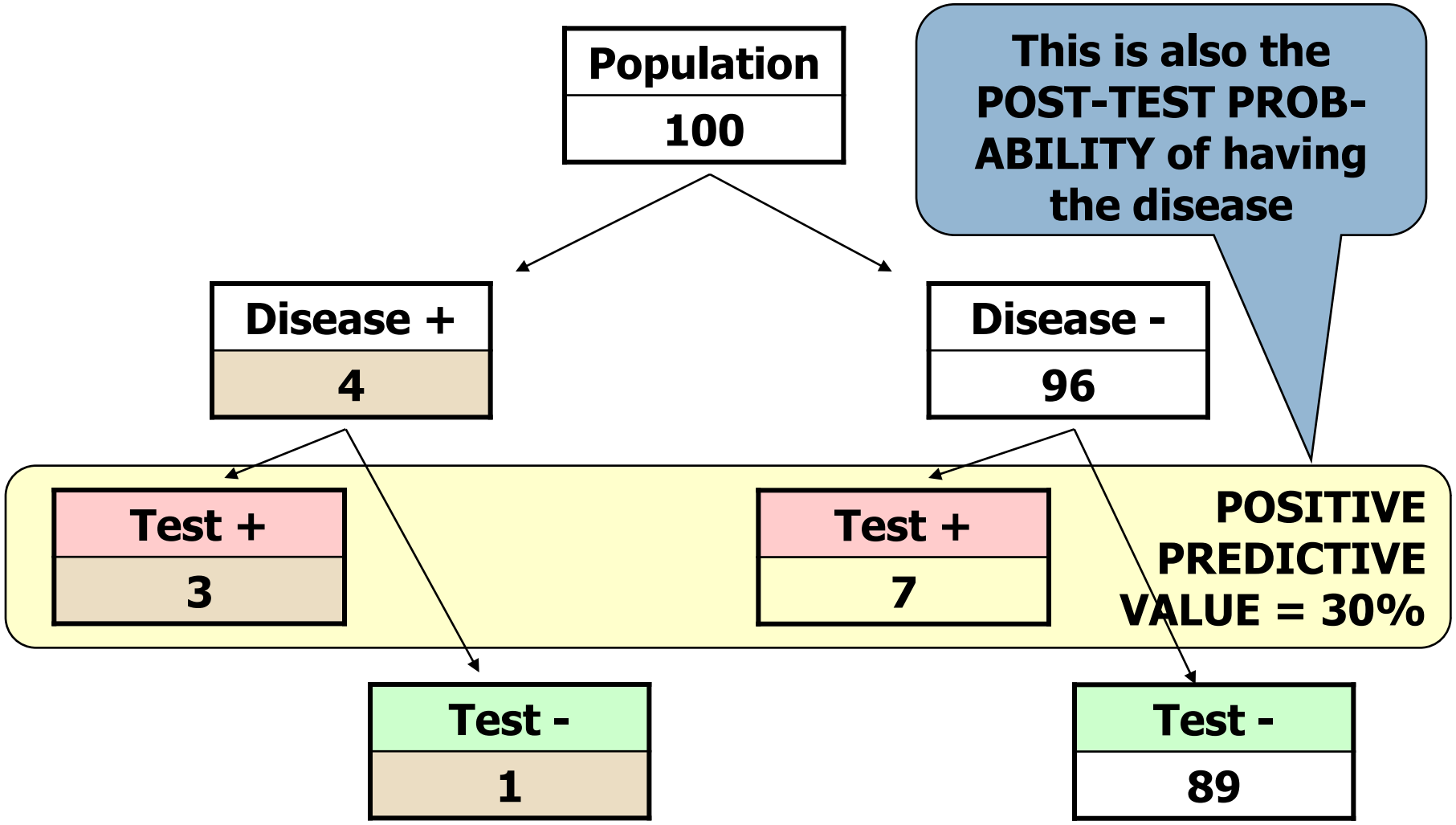
OF THE 4 PEOPLE WITH THE DISEASE, THE TEST WILL DETECT 3



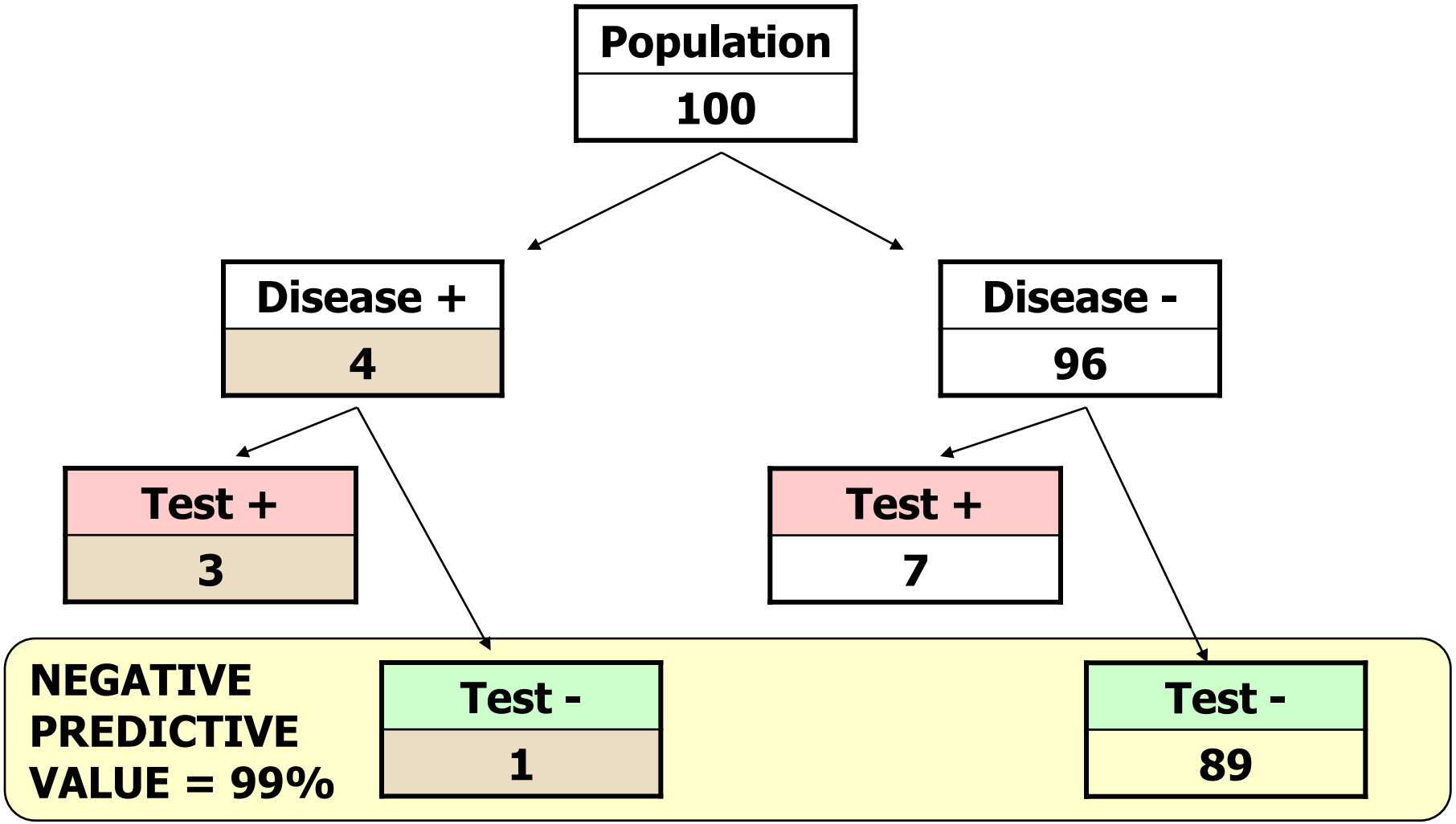
AMONG THE 96 PEOPLE WITHOUT THE DISEASE, 7 WILL TEST POSITIVE



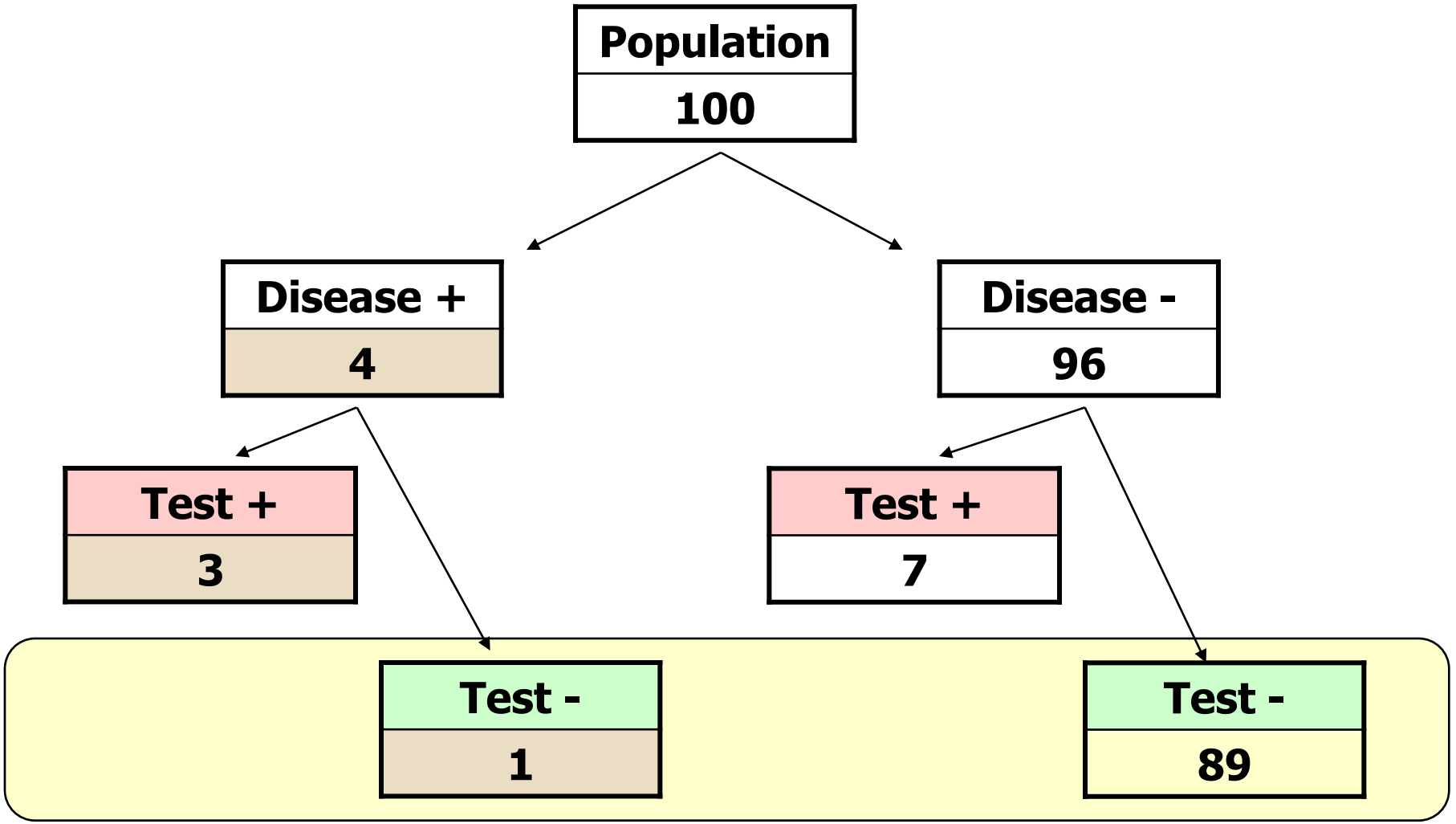
AMONG THOSE WHO TEST POSITIVE, 3 IN 10 WILL ACTUALLY HAVE THE DISEASE



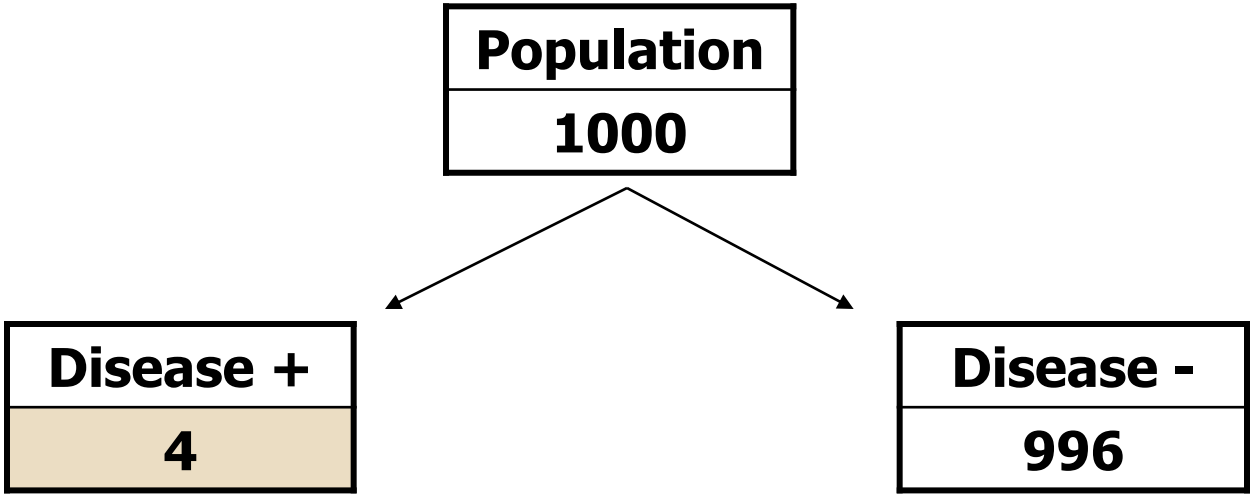
AMONG THOSE WHO TEST NEGATIVE, 89 OF 90 WILL NOT HAVE THE DISEASE



CONVERSELY, IF SOMEONE TESTS NEGATIVE, THE CHANCE OF HAVING THE DISEASE IS ONLY 1 IN 90

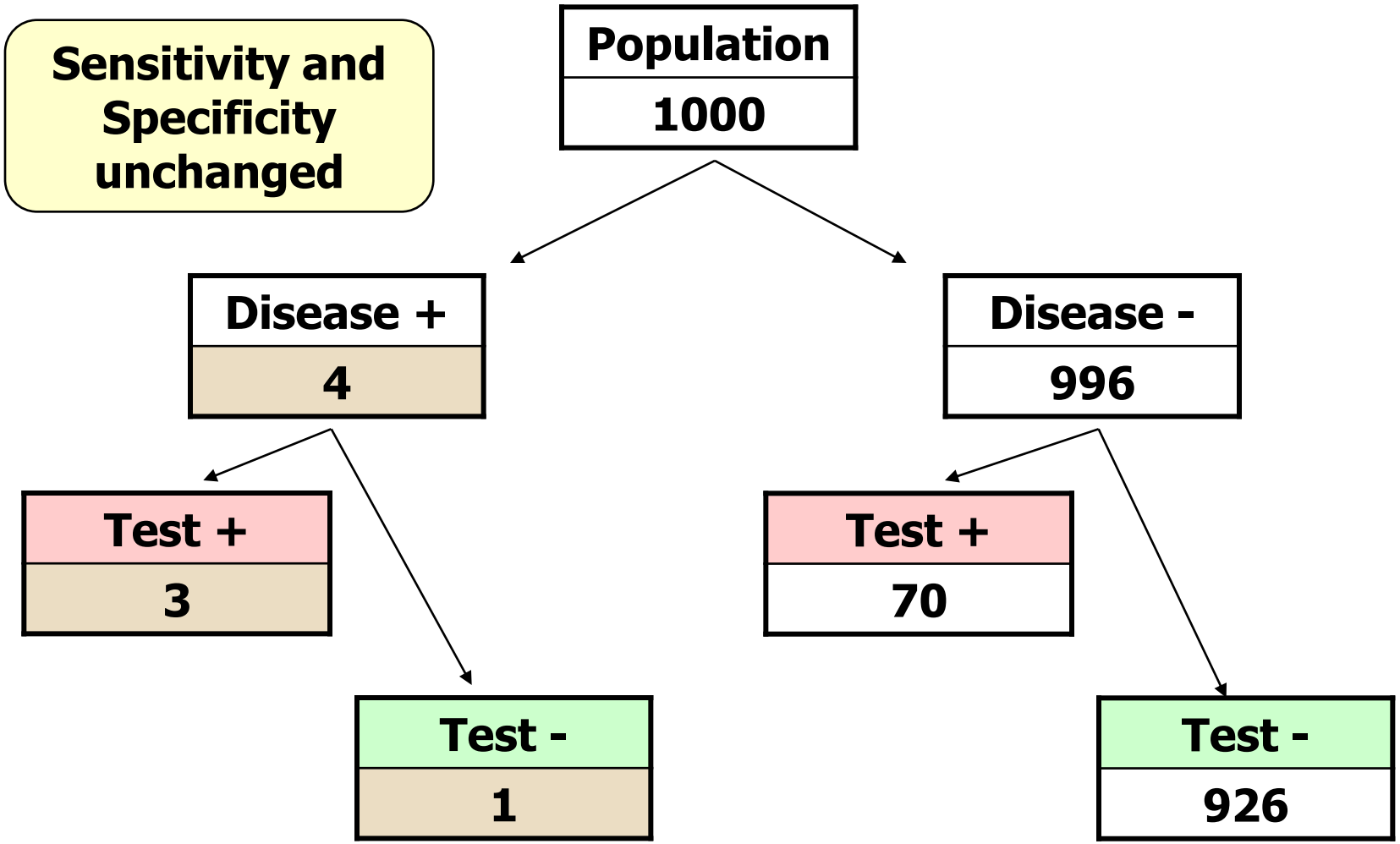


PREDICTIVE VALUES AND CHANGING PREVALENCE

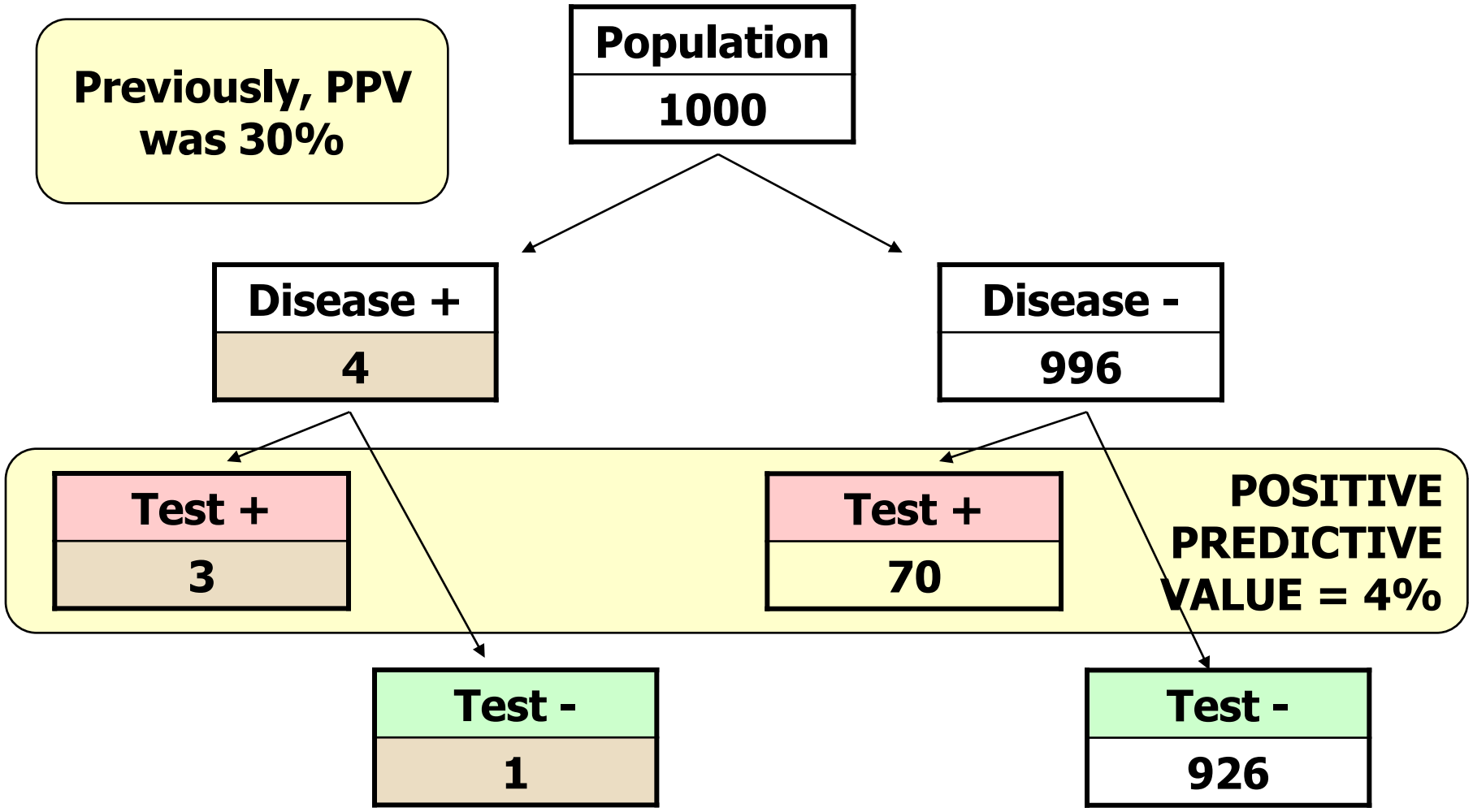


Prevalence reduced by an order of magnitude from 4% to 0.4%

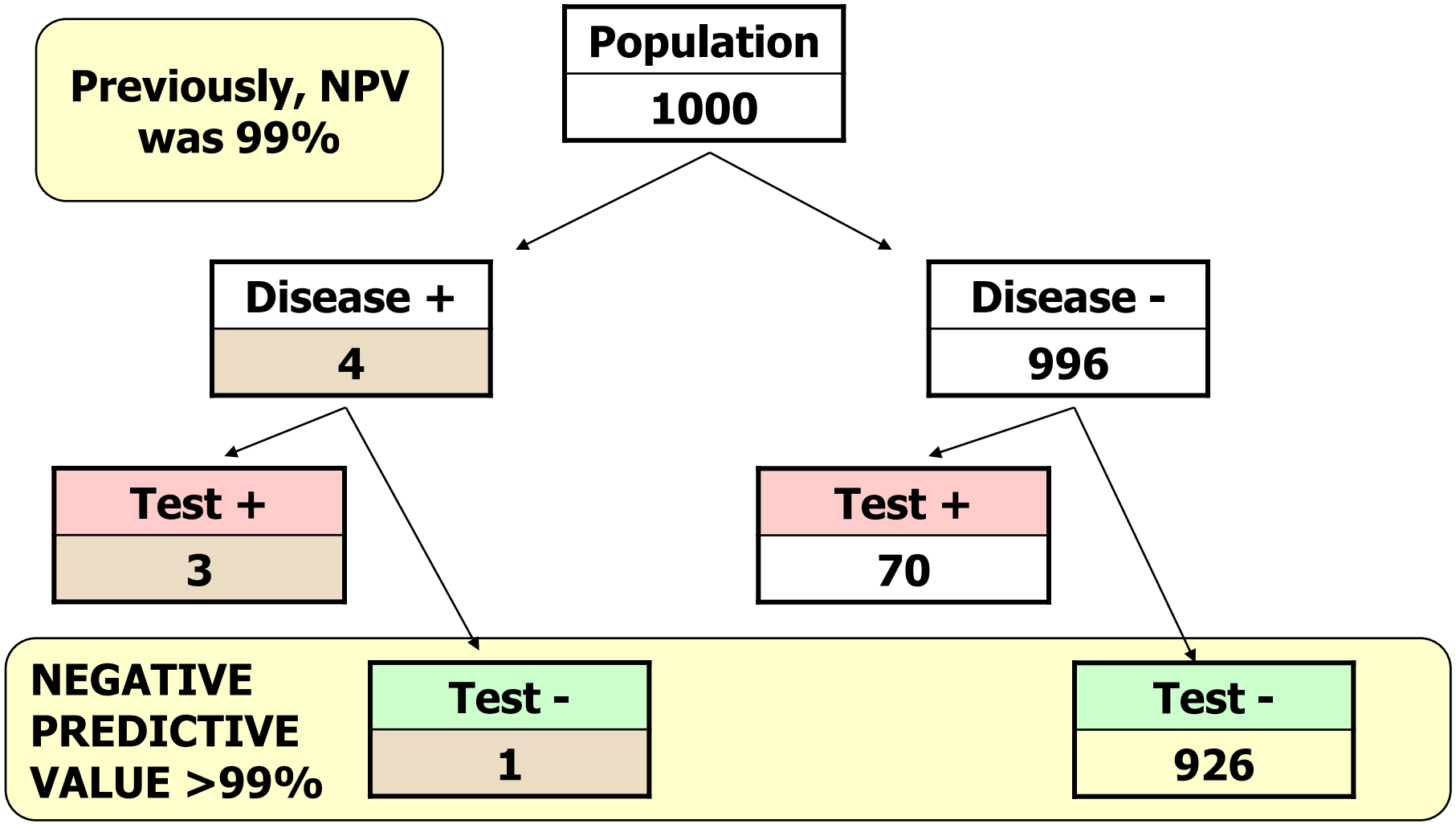
PREDICTIVE VALUE AND CHANGING PREVALENCE



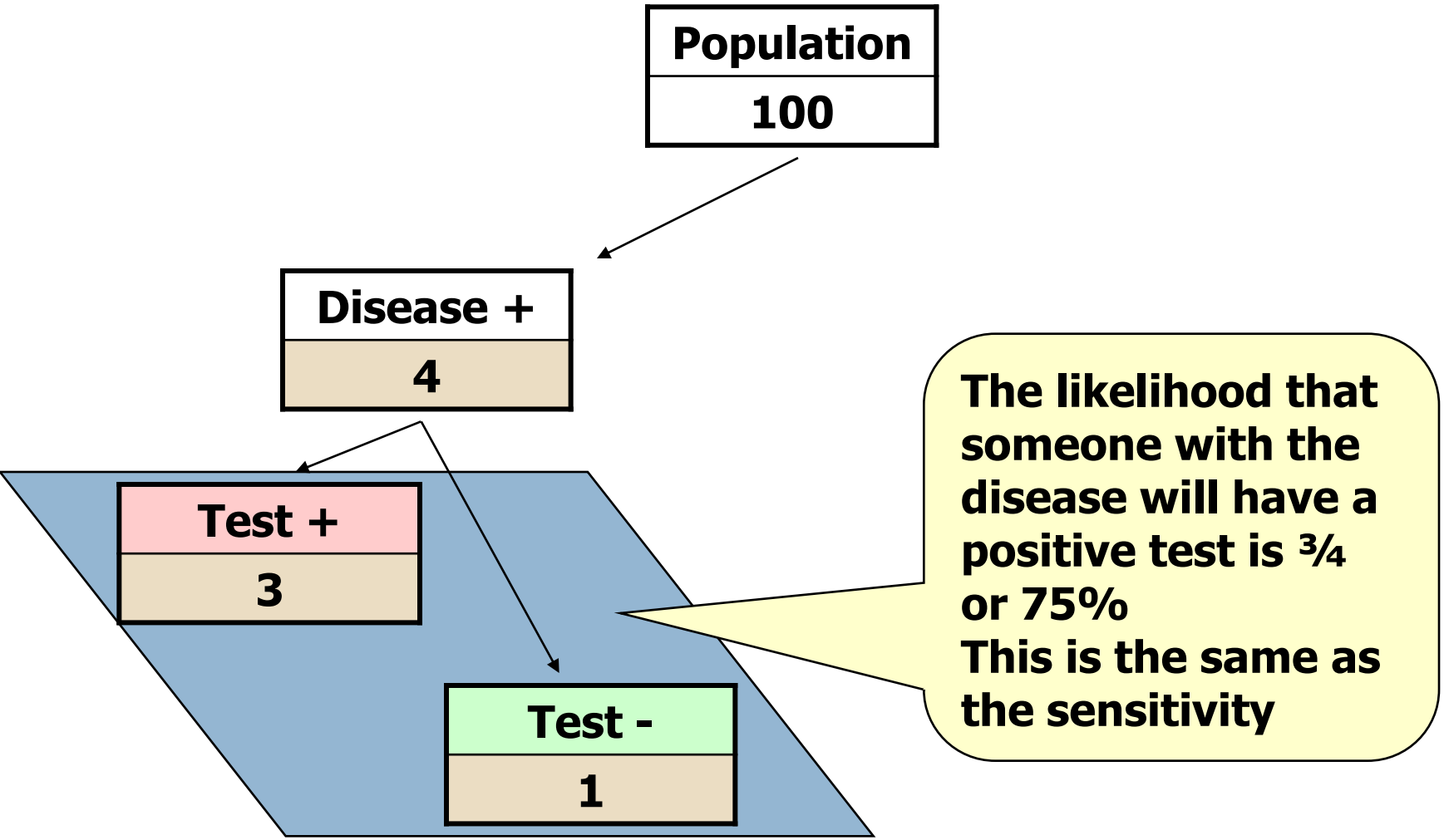
POSITIVE PREDICTIVE VALUE AT LOW PREVALENCE



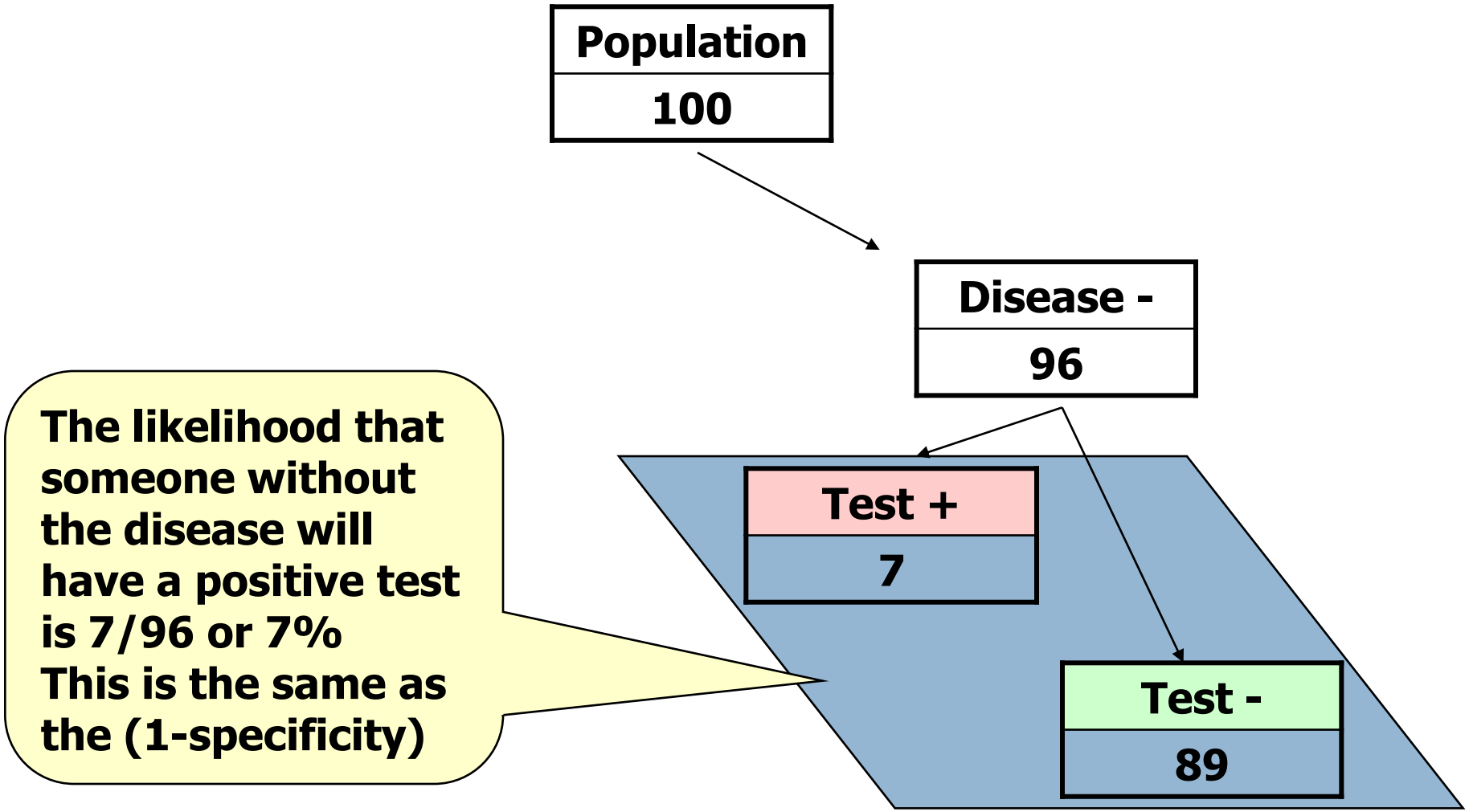
NEGATIVE PREDICTIVE VALUE AT LOW PREVALENCE



LIKELIHOOD


Population
100
Disease +
4
Test +
3
Test -
1
The likelihood that someone with the disease will have a positive test is ¾ or 75%
This is the same as the sensitivity

LIKELIHOOD II



LIKELIHOOD RATIO

$$\text{LIKELIHOOD RATIO} = \frac{\text{LIKELIHOOD OF POSITIVE TEST GIVEN THE DISEASE}}{\text{LIKELIHOOD OF POSITIVE TEST IN THE ABSENCE OF THE DISEASE}}$$

$$= \frac{\text{SENSITIVITY}}{\text{1- SPECIFICITY}} = \frac{0.75}{0.07} = 10.7$$

A Likelihood Ratio of 1.0 indicates an uninformative test (occurs when sensitivity and specificity are both 50%)

The higher the Likelihood Ratio, the better the test (other factors being equal)

odds

- Pre-test probability (prevalence) =(a+c)/(a+b+c+d)

Prevalence = 4/100= 4%

- Pre-test odds = prevalence/(1-prevalence)

Pre-test odds= 4/(1-4)= 0.042

- Post-test odds = pre-test odds * LR

  Post-test odds= 0.042 * 10.7=0.446

- Post-test probability= post-test odds/(post-test odds +1)

  Post-test odds=0.446/1.446=15.47

Is the test helpful (valid)? The Youden Index

Youden Index = (Sensitivity+Specificity)-1

For a test to be useful, then

sensitivity + specificity > 1

(Youden Index > 0)

Examples:

sensitivity = 0.5

specificity = 0.5

Youden index = 0

Example

- Suppose that we are working up a patient with anemia. The probability that she has IDA is 50% (i.e. odds=50:50).
- We are looking for the usefulness of performing a serum Ferritin on our patient as a mean for detecting IDA.
- The reference standard of a bone marrow stain for Fe is our GOLD STANDARD.

		Bone Marrow		
		Positive	Negative	
Test result	Positive	**a=731**	**b=270**	**a+b=1001**
(Ferritin)	Negative	**c=78**	**d=1500**	**c+d=1578**
		a+c=809	**b+d=1770**	**A+b+c+d = 2579**

Results

- Sensitivity: a/(a+c)=731/809=90%
- Specificity: d/(b+d) =1500/1770 = 85%
- LR(+) = 0.90/(1-0.85)= 6:1

Thank you