

# Screening and Diagnosis

# Screening and diagnosis

## NO SYMPTOMS

screening - identify the possible presence of an as-yet-undiagnosed disease in a person without signs or symptoms

## SYMPTOMS

diagnosis - determining which disease or condition explains a person's signs or symptoms

# Answering questions

does a person have cancer?

does a person have HIV?

does a person have depression?

does a person with abdominal pain have  
appendicitis?

does a person with a sore throat have strep  
throat?

# Clinical Context

Each question and physical examination is a diagnostic test in itself, each with a sensitivity and specificity

The probability that is 'sufficient' to reach a 'diagnosis' varies with the seriousness, treatability or novelty of the diagnosis being considered



# Bayes theorem

# Commonly used measures for evaluating the clinical performance of diagnostic and screening tests

Sensitivity=the probability that an individual with the disease has a positive test result

Specificity=the probability that an individual without the disease has a negative test result

Positive predictive value=the probability that an individual with a positive test result has the disease

Negative predictive value=the probability that an individual with a negative test result does not have the disease

Positive likelihood ratio=the probability that an individual with the disease has a positive test result, divided by the probability that an individual without the disease has a positive test result (that is,  $\text{sensitivity}/(1-\text{specificity})$ )

Negative likelihood ratio=the probability that an individual with the disease has a negative test result, divided by the probability that an individual without the disease has a negative test result (that is,  $(1-\text{sensitivity})/\text{specificity}$ )

Area under the receiver operating characteristic curve (AUROC)=the probability that a classifier will correctly rank a randomly chosen person with the disease higher than a randomly chosen person without the disease (that is, the area under a plot of sensitivity against  $(1-\text{specificity})$ )

# Sensitivity and Specificity

Sensitivity - ranges from 0% to 100%

Specificity - ranges from 0% to 100%

these do NOT take prevalence into account

Prevalence = the proportion of individuals in a population having a disease at a particular time point = pre-test probability - ranges from 0% to 100%

Predictive value varies with the prevalence of the condition - ranges from 0 to 100%

Likelihood ratios can take into account different prevalences

less than 1 = a negative likelihood ratio

greater than 1 = a positive likelihood ratio

# Diagnosis in primary care: probabilistic reasoning

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## *Box 1. Terminology and definitions*

**Pre-test probability** = prevalence

**Post-test probability of a positive test** = positive predictive value

**Post-test probability of a negative test** = 1 – negative predictive value

**Likelihood ratio (LR)** = 
$$\frac{\text{probability of test result in patients with disease}}{\text{probability of test result in patients without disease}}$$

Likelihood ratio positive sensitivity/(1-specificity) (raises probabilities)

Likelihood ratio negative (1-sensitivity)/specificity (lowers probabilities)

# Likelihood ratios

LR+ = probability that a test is **positive** in the people with the disease/the probability that the test is **positive** in people without the disease

LR+ = sensitivity/1-specificity

LR- = probability that a test is **negative** in the people with the disease/the probability that the test is **negative** in people without the disease

LR- = 1-sensitivity/specificity

greater than 1 = a positive likelihood ratio  
less than 1 = a negative likelihood ratio

How to calculate post-test probability using prevalence and LRs

# Likelihood/ Fagan nomogram

Pre-test  
probability

0.001  
0.002  
0.003  
0.005  
0.007  
0.01  
0.02  
0.03  
0.05  
0.07  
0.1  
0.2  
0.3  
0.4  
0.5  
0.6  
0.7  
0.8  
0.9  
0.93  
0.95  
0.97  
0.98  
0.99  
0.993  
0.995  
0.997  
0.998  
0.999

Likelihood  
ratio

1000  
500  
200  
100  
50  
20  
10  
5  
2  
1  
0.5  
0.2  
0.1  
0.05  
0.02  
0.01  
0.005  
0.002  
0.001

Post-test  
probability

0.999  
0.998  
0.997  
0.995  
0.993  
0.99  
0.98  
0.97  
0.95  
0.93  
0.9  
0.8  
0.7  
0.6  
0.5  
0.4  
0.3  
0.2  
0.1  
0.07  
0.05  
0.03  
0.02  
0.01  
0.007  
0.005  
0.003  
0.002  
0.001

Table 4. Likelihood ratios and their approximate post test probabilities (modified by McGee 2002)<sup>8</sup>

Likelihood ratios		Approximate changes in post-test probabilities	
Values between 0 and 1 decrease the probability of disease			
0.1	Strong evidence	Large	-45%
0.2		Moderate	-30%
0.3			-25%
0.4			-20%
0.5	Weak evidence	Slight	-15%
Likelihood ratio = 1		None	0%
Values greater than 1 increase the probability of disease			
2	Weak evidence	Slight	+15%
3			+20%
4			+25%
5		Moderate	+30%
6	+35%		
8	+40%		
10	Strong evidence	Large	+45%



# Useful apps and on-line tools

MedCalX - calculate likelihood ratios from sensitivity and specificity AND post-test probability calculator



ROGERS 6:56 PM 83%

< Back Likelihood Ratios ⓘ

Sensitivity 90 %

Specificity 85 %

LR (pos) 6

LR (neg) 0.12

ROGERS 6:55 PM 83%

< Back Post-test Probability (LR) ⓘ

Pre-test probability 25 %

Likelihood Ratio 8

Post-test probability 72.7 %

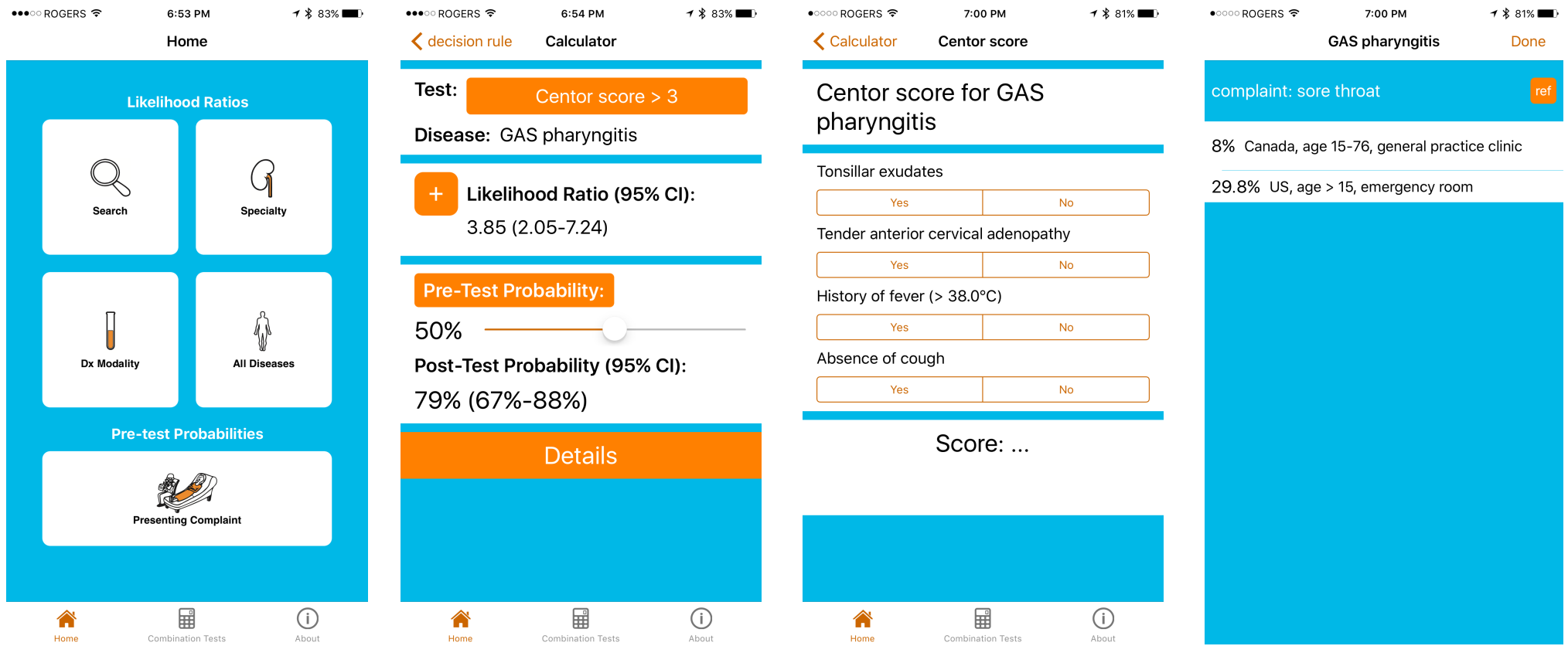
7	8	9
4	5	6
1	2	3
0	.	ⓧ

%

7	8	9
4	5	6
1	2	3
0	.	ⓧ

# Useful apps and on-line tools

DxLogic - listing of LR and pre-test probabilities and a post-test calculator



[Irdatabase.com](http://Irdatabase.com) - home of DxLogic

Oct. 12th, 2016: Check out my newest project: [InvestLogic](#), an evidence-based guide and iOS app to help you save for retirement.

Search the Database

### Likelihood Ratios

Specialty

[cardiology](#)

[critical care](#)

[dermatology](#)

[endocrinology](#)

[gastroenterology](#)

[general surgery](#)

[gynecology](#)

[haematology](#)

[infectious diseases](#)

[nephrology](#)

[neurology](#)

[oncology](#)

[orthopedics](#)

[respirology](#)

[rheumatology](#)

[urology](#)

[vascular surgery](#)

Diagnostic Modality

[decision rule](#)

[EKG](#)

[history](#)

[laboratory](#)

[physical exam](#)

[imaging](#)

All Diseases

[list](#)

### Pre-test Probabilities

Presenting Complaint

[abdomen](#)

[abdominal pain](#)

[acute liver failure](#)

[suspected cauda equina syndrome](#)

[suspected lower GI bleed](#)

[suspected upper GI bleed](#)

[extremities](#)

[ankle injury](#)

[monoarthritis](#)

[suspected deep vein thrombosis](#)

[genitourinary](#)

[acute renal failure](#)

[hematuria \(isolated and persistent\)](#)

[nephrotic syndrome](#)

[proteinuria in patient with diabetes](#)

[suspected ureteral stone](#)

[vaginal complaint](#)

[women presenting with 1 or more symptoms of UTI](#)

[head and neck](#)

[head injury](#)

[neck injury](#)

[sore throat](#)

[Irdatabase.com](#) - home of DxLogic

# Useful apps and on-line tools

http://www.thennt.com/home-lr/

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BY SPECIALTY

BY SYSTEM

ALPHABETICALLY

## Diagnosis (LR) Reviews

You'll find all of our diagnostic/likelihood ratio reviews, arranged by medical specialty, organ system, and alphabetically.

### Diagnosis (LR) Reviews by Specialty

#### Cardiology

- Aortic Dissection
- Deep Venous Thrombosis (DVT)
- Dyspnea Due to Heart Failure (With Chronic Respiratory Disease)
- Dyspnea Due to Heart Failure (Without Chronic Respiratory Disease)

#### Critical Care

- Aortic Dissection
- Deep Venous Thrombosis (DVT)

#### Geriatrics

- Hypovolemia

#### Hematology

- Deep Venous Thrombosis (DVT)

#### Infectious Disease

- Malaria in Returning Travelers
- Osteomyelitis in Diabetic Patients
- Pertussis (Whooping Cough)
- Streptococcal Pharyngitis

#### Neurology

- Hemorrhagic Stroke
- Migraine

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## Streptococcal Pharyngitis

Diagnostics and Likelihood Ratios, Explained

### Positive Findings (Patient Has This)

Symptoms	Increased Disease Probability (Positive Likelihood Ratio)
Strep exposure in the past 2 weeks	1.9× (1.3-2.8)
Myalgias	1.4× (1.1-1.7)
No cough	1.1-1.7
History of sore throat	1.0-1.1
Reported fever	0.97-2.6
Headache	0.81-2.6
Nausea	0.76-3.1
Duration <3d	0.72-3.5

Signs on Physical Exam	Increased Disease Probability (Positive Likelihood Ratio)
Tonsillar exudates	3.4× (1.8-6.0)
Pharyngeal exudates	2.1× (1.4-3.1)
Tonsillar or pharyngeal exudates	1.8× (1.5-2.3)
Any Exudates	1.5-2.6
Tonsillar swelling/enlargement	1.4-3.1
Palatine petechiae	1.4× (0.48-3.1)
Ant. Cervical lymph node tenderness	1.2-1.9
Measured temp >37.8 C	1.1-3.0
Male sex	0.87× (0.72-1.05)
No coryza	0.86-1.6
Measured temp >=38.3 °C	0.68-3.9
Pharynx injected	0.66-1.63
Ant. Cervical lymph node swollen/enlarged	0.47-2.9
Rash	0.06-35

Clinical Criteria Points (Ignoring Age Modification)	Increased Disease Probability (Positive Likelihood Ratio)
4 Points	6.3×
3 Points	2.1×
2 Points	0.75
0 Points	0.16
1 Points	0.3

### Negative Findings (Patient Doesn't Have This)

Symptoms	Decreased Disease Probability (Negative Likelihood Ratio)
Duration <3d	0.15-2.2
Reported fever	0.32-1.0

#### RELATED REVIEWS

#### OTHER EBM RESOURCES

- MDCalc
- BMJ Evidence Updates
- JMAAEvidence - The Rational Clinical Exam Series

# Useful apps and on-line tools

http://getthediagnosis.org/

## GetTheDiagnosis.org: A Database of Sensitivity and Specificity

Search:

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GetTheDiagnosis is a collaborative database for health professionals to share knowledge on the **sensitivity** and **specificity** of history questions, physical exam findings, and lab and imaging tests. You can use it to look up sensitivity and specificity, or submit an entry of your own from the literature!

We are currently up to **300** diagnoses and **1102** findings, for a total of **1624** entries! Follow our [newest entries](#) with our [RSS feed](#).

### Helicobacter pylori: Sensitivity and Specificity

**Introduction:** From UpToDate (<http://www.utdol.com/online/content/topic.do?topicKey=acidpep/4732>):

The ACG guidelines made the following conclusions:

- Testing for H. pylori should be performed only if the clinician plans to offer treatment for positive results.
- Testing is indicated in patients with active peptic ulcer disease, a past history of documented peptic ulcer or gastric MALT lymphoma.
- The test-and-treat strategy for H. pylori (ie, test and treat if positive) is a proven management strategy for patients with uninvestigated dyspepsia who are under the age of 55 years and have no "alarm features" (bleeding, anemia, early satiety, unexplained weight loss, progressive dysphagia, odynophagia, recurrent vomiting, family history of GI cancer, previous esophagogastric malignancy).
- Deciding which test to use in which situation relies heavily upon whether a patient requires evaluation with upper endoscopy and an understanding of the strengths, weaknesses, and costs of the individual test.

[\[Edit Diagnosis\]](#) [\[Merge dx\]](#) [\[Add prevalence\]](#)

**Tags:** [Gastrointestinal Problem Infection](#) [Tag this Diagnosis](#).



The sensitivity and specificity of findings for Helicobacter pylori are listed below. See the left navigation bar to change the display.

#### Sensitive and Specific Findings

Finding	Sensitivity	Specificity	Comments, Study
Antral biopsy urease test <a href="#">↗</a>	90%	95%	[sens/spec is per UpToDate] One reason for lack of specificity: If specimen contains less common non-pylori gastric helicobacters, which give only weakly positive results in the biopsy urease test. Positive identification of these bacteria requires visualization of the characteristic long, tight spirals in histologic sections. • Adapted from Harrison's Online Chapter 144: Helicobacter pylori infections <b>Study:</b> Am J Gastroenterol. 2007 Aug;102(8):1808-25. PMID 17608775
Urea breath test <a href="#">↗</a>	93%	92%	in patients with an UGIB. <b>Study:</b> Am J Gastroenterol. 2006 Apr;101(4):848-63. PMID 16494583

#### Specific Findings

Finding	Sensitivity	Specificity	Comments, Study
Biopsy culture <a href="#">↗</a>	45%	98%	In addition to diagnosis, biopsy culture allows for determination of antibiotic sensitivity <b>Study:</b> Am J Gastroenterol. 2006 Apr;101(4):848-63. PMID 16494583
Rapid urease test <a href="#">↗</a>	67%	93%	in patients with UGIB. <b>Study:</b> Am J Gastroenterol. 2006 Apr;101(4):848-63. PMID 16494583
Biopsy histology <a href="#">↗</a>	70%	90%	in patients with UGIB. <b>Study:</b> Am J Gastroenterol. 2006 Apr;101(4):848-63. PMID 16494583

#### Sensitive Findings

Finding	Sensitivity	Specificity	Comments, Study
Serology <a href="#">↗</a>	88%	69%	in patients with UGIB <b>Study:</b> Am J Gastroenterol. 2006 Apr;101(4):848-63. PMID 16494583
Stool antigen test <a href="#">↗</a>	87%	70%	in patients with UGIB <b>Study:</b> Am J Gastroenterol. 2006 Apr;101(4):848-63. PMID 16494583

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# SCREENING EXAMPLE

# 6 rapid human immunodeficiency virus (HIV) antibody tests

Sensitivity was >95% and specificity was >99% for all rapid tests

Clin Infect Dis 2011;52:257-63

2% prevalence	HIV	No HIV	
Test +	19	10	29
Test -	1	970	971
	20	980	1000

LR+

= sensitivity/1-specificity

=

LR-

= 1-sensitivity/specificity

=

If prevalence	If test positive Post test probability	If test negative Post test probability
0.1%		
1%		
2%		
10%		
40%		

<http://bit.ly/2fd9sjf>

# DIAGNOSIS EXAMPLE



# GABHS (strep) rapid antigen detection test kit, in comparison with oropharynx swab culture

**Table 4** - Comparison between oropharynx swab culture and latex particle agglutination test for detecting GABHS\*

Latex	Culture					
	Positive		Negative		Total	
Positive	49	90.7%	19	10.9%	68	29.7%
Negative	5	9.3%	156	89.1%	161	70.3%
Total	54	100%	175	100%	229	100%

Sensitivity                      LR +

Specificity                      LR -

# Pre-test probability

General practice clinic in Canada - people with a sore throat who have Strep ~10%

LR + =

= Post-test probability

LR - =

= Post-test probability

Prevalence	If positive Post test probability	If negative
1		
10		
40		

# Rapid Antigen Group A Streptococcus Test to Diagnose Pharyngitis: A Systematic Review and Meta-Analysis

## Enzyme immunoassay

CHILDREN - pooled sensitivity was 86% (95% CI, 79–92%) and the pooled specificity was 92% (95% CI, 88–95%)

LR + = 10.8 LR - = 0.15

ADULTS - the pooled sensitivity was 86% (95% CI, 81–91%) and the pooled specificity was 97% (95% CI, 96 to 99%)

LR + = 28.7 LR - = 0.14

# SCREENING EXAMPLE

# Thickening of the Nuchal Translucency - Ultrasound



**12 week fetus with normal NT**



**Trisomy 21 fetus with increased NT**

**Table 5.** Calculated LRs (Sensitivity/False-Positive Rate) of Sonographic Findings for Fetal Down Syndrome

<b>Sonographic Marker</b>	<b>LR Overall*</b>	<b>LR as Isolated Markert</b>	<b>95% CI</b>
Nuchal thickening	61	11	5.5–22
Hyperechoic bowel	33.8	6.7	2.7–16.8
Short humerus	15.3	5.1	1.6–16.5
Short femur	6.1	1.5	0.8–2.8
EIF	6.3	1.8	1.0–3.2
Pyelectasis	5.2	1.5	0.6–3.6

\*LR when a marker was present either as an isolated finding or in combination with other markers.

†LR when a marker was present as an isolated finding.

# Pre-screening probability

Nuchal thickening LR = 11

The risk of Down's syndrome (trisomy 21) varies with maternal age:

1:1,500 (0.07%) at 20 years

1:800 (0.1%) at 30 years

1:270 (0.4%) at 35 years

1:100 (1%) at 40 years

>1:50 (2%) at 45 years and over

Prevalence	Post test probability If nuchal thickening positive
0.07%	
0.1%	
0.4%	
1%	
2%	

# DIAGNOSIS EXAMPLE



# EVIDENCE-BASED PRACTICE

ACROSS THE HEALTH PROFESSIONS

2ND EDITION

Tammy Hoffmann • Sally Bennett • Chris Del Mar



**evolve**resources  
learning solutions

## Chapter 6

Evidence about diagnosis

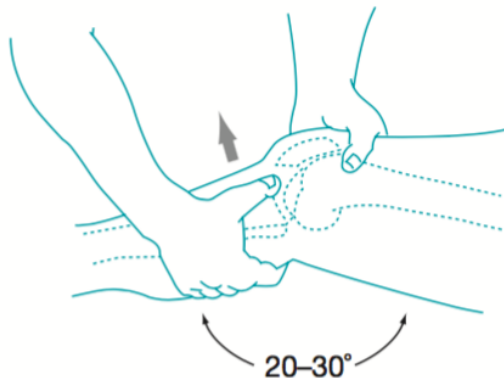
Jenny Doust

24-year-old man who twisted his right knee while playing football the day before. He has been suffering with pain and swelling in the knee since the time of the injury, and is able to weight-bear but with difficulty.

Question - meniscal injury, an injury to the anterior cruciate ligament or a soft-tissue injury

Best way to assess - arthroscopy  
next best MRI - not 100% but...

**Lachman's test**



A positive test result is movement of the knee with a soft or mushy endpoint

# Lachman's test

PPV

	Ligament damage	No ligament damage	
Test +	37	14	51
Test -	22	130	152
	59	144	203

NPV

Prevalence in this example is

Sensitivity

LR+

Specificity

LR-

# Prevalence effect on predictive value

- total of 100 people

## **Prevalence = 15%**

Sensitivity =  $10/15 = 67\%$

Specificity =  $45/85 = 53\%$

PPV =  $10/50 = 20\%$

NPV =  $45/50 = 90\%$

## **Prevalence = 30%**

Sensitivity =  $20/30 = 67\%$

Specificity =  $37/70 = 53\%$

PPV =  $20/53 = 38\%$

NPV =  $37/47 = 79\%$

## **Prevalence = 60%**

Sensitivity =  $40/60 = 67\%$

Specificity =  $21/40 = 53\%$

PPV =  $40/59 = 68\%$

NPV =  $21/41 = 51\%$

