

# Lab Values in Research: an Introduction

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# Goals

- ▶ This is from a *clinical* (ie not primarily *statistical*) research perspective
- ▶ Discuss sensitivity and specificity
- ▶ Discuss predictive value
- ▶ Review Type I & Type II error
- ▶ Consider reliability, validity

# Case presentation

- ▶ 24 yo F presents with fever, cough x 3d (whitish/yellow sputum), dyspnea
- ▶ Exam: Temp 39.1, HR 122, BP 106/78, O2 88%
- ▶ Crackles diffusely, no dullness
- ▶ You order a CBC & chemistries
- ▶ WBC 6.8
- ▶ Cr 1.2

# Chest X-Ray



## Question: what to make of the WBC (6.8)?

- ▶ *Maybe* it's "normal" (range ~4-11)?
- ▶ *Maybe* it's low (wouldn't we expect it to be high)?
- ▶ ..or *maybe* it's high?
  
- ▶ How could it be *high*?!

Well, what if the CXR was like *this*:



# This is a story about a test's accuracy

- ▶ The *sensitivity* of the WBC can be thought of as: “how many pneumonias will be picked up by a high white count?”
- ▶ The *specificity* of the WBC can be thought of as: “how many high white counts indicate pneumonia?”
- ▶ We normally treat a high white count as fairly *sensitive* (pneumonias are typically associated with high WBC) but not very *specific* (lots of things cause high WBC *besides* pneumonia)

# Mathematical expression of sens/spec

- ▶ Sensitivity:
  - ▶ true positive tests/# of people with disease
- ▶ Specificity:
  - ▶ true *negative* tests/# of people who *don't* have the disease (this is counter-intuitive!)



		True condition	
		Condition positive	Condition negative
Predicted condition	Total population		
	Predicted condition positive	<b>True positive</b>	<b>False positive,</b> [redacted]
	Predicted condition negative	<b>False negative,</b> [redacted]	<b>True negative</b>

# Sensitivity & Specificity are *not* predictive value

- ▶ Predictive value tells you whether the test is *actually telling you what you want to know*
- ▶ Meaning: is a positive test *really* positive? Does this mean they *really* have the disease?
- ▶ This is not the same thing as sens & spec...
- ▶ Because it's affected by *prevalence*
- ▶ Let's take mammograms as an example

Screening Mammography in US women age 40-50  
with (theoretical) 99% Sensitivity & Specificity  
(21.5 million women in this age range)

- 1% of 21.5 million women = 215,000 **false positives**
- 35,000 cases invasive breast cancer = 360 false negatives  
(basically, zero)
- Total positive mammograms: 250,000 (215K + 35K)
- Positive predictive value:  $35,000 / 250,000$
- Equals ***14 percent***

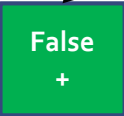
Population without disease

Population with disease

False Positive →



Total number of positive tests:



True positive

## How probability affects predictive value: Urine Culture

- ▶ 55 yo F with urgency but no dysuria, hematuria, fever, pelvic or bladder pain
- ▶ Urine culture grows 100K *E coli*
- ▶ Does this mean she has a UTI?
- ▶ The symptoms (or lack thereof) and signs (or lack thereof) affect the *pre-test probability*, which works a bit like how prevalence affects predictive value as well
- ▶ Low pre-test prob increases false positives!

# Reliability & Validity

- ▶ *Reliability* refers to how many times you can *reliably* produce the same (or almost the same) outcomes doing a test the exact same way
- ▶ *Example:* CBC, chemistries, other serum labs
- ▶ Less reliable tests might include chest x-rays (dependent on movement, inhalation, rotation)
- ▶ Validity refers to whether the test you are using is measuring the thing you want to measure

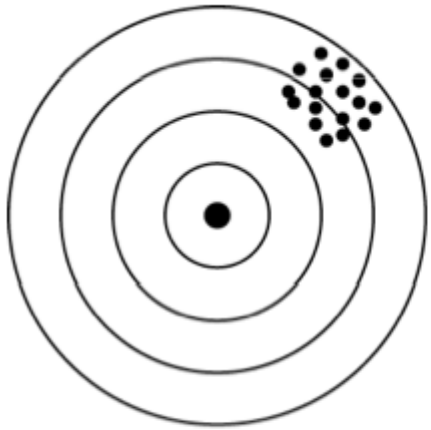
# Reliability & Validity con't

- ▶ *Validity* refers to whether the test you are using is measuring the thing you want to measure
- ▶ A scale that gives you the same weight each time you step on it is *reliable*
- ▶ A scale that is calibrated accurately is *valid*



Not my feet or weight!

# What a test aims for in terms of reliability and validity



Reliable  
Not valid



Questions?

# Type I & II errors in continuous variables

