2019-08-14

Lab Values in Research: an Introduction

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Lab Values in Research: an Introduction

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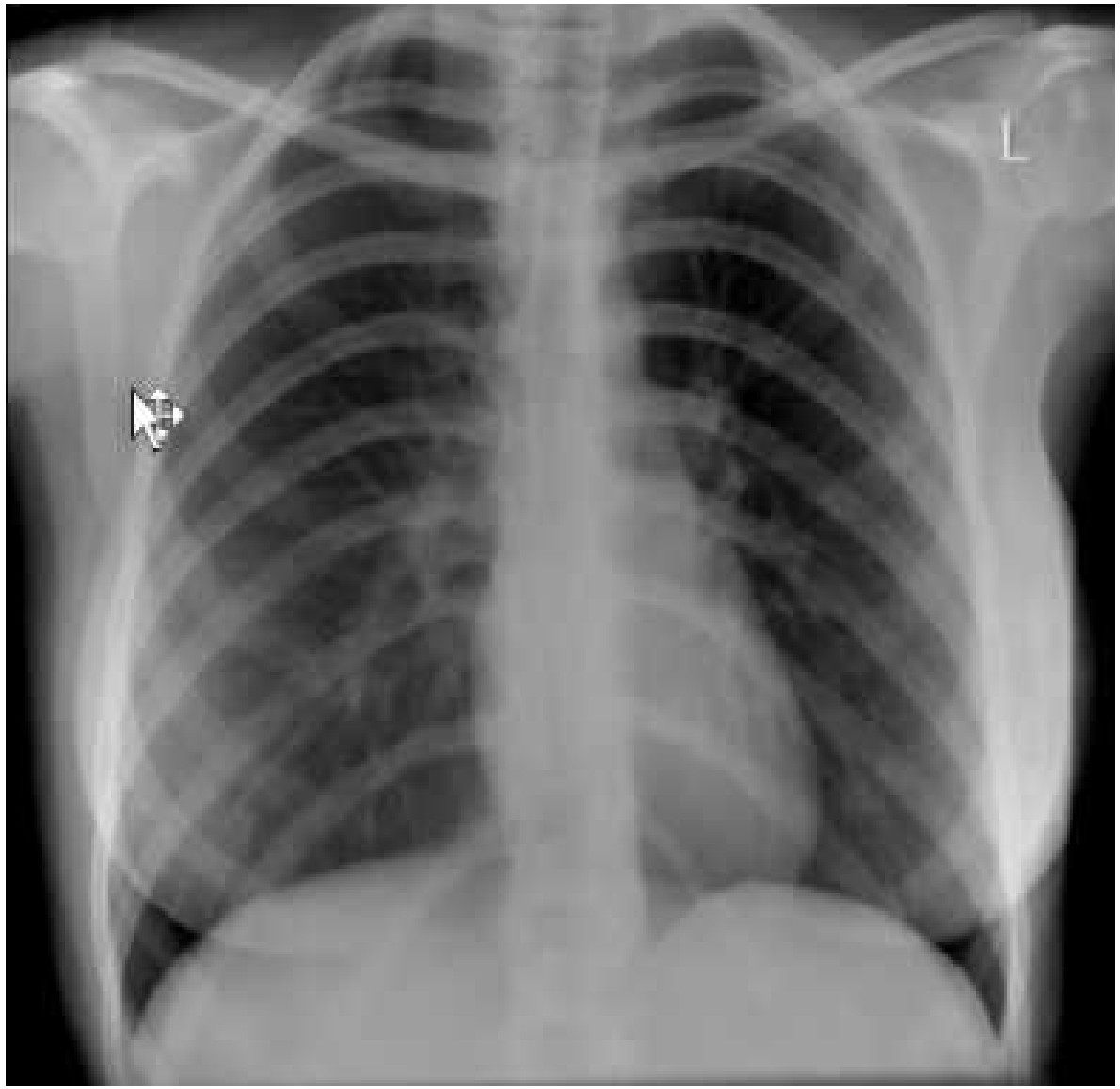
Goals

- 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	
	Total population	Condition positive	Condition negative
Predicted condition	Predicted condition positive	**True positive**	**False positive,**
	Predicted condition negative	**False negative,**	**True negative**

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
False Positive→
Population with disease
Total number of positive tests:
False +
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

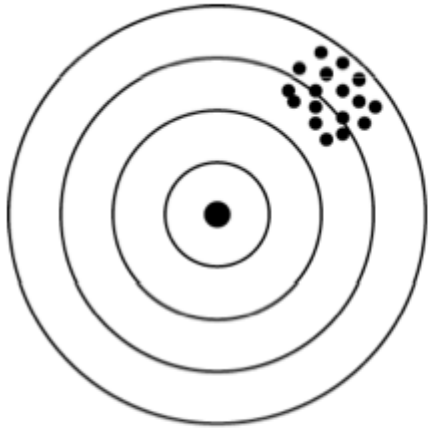
- *Reliability* refers to how many times you can *reliably* produce the same (or almost the same) outcomes doing a test the exact same way
- *Example:* CBC, chemistries, other serum labs
- Less reliable tests might include chest x-rays (dependent on movement, inhalation, rotation)
- Validity refers to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

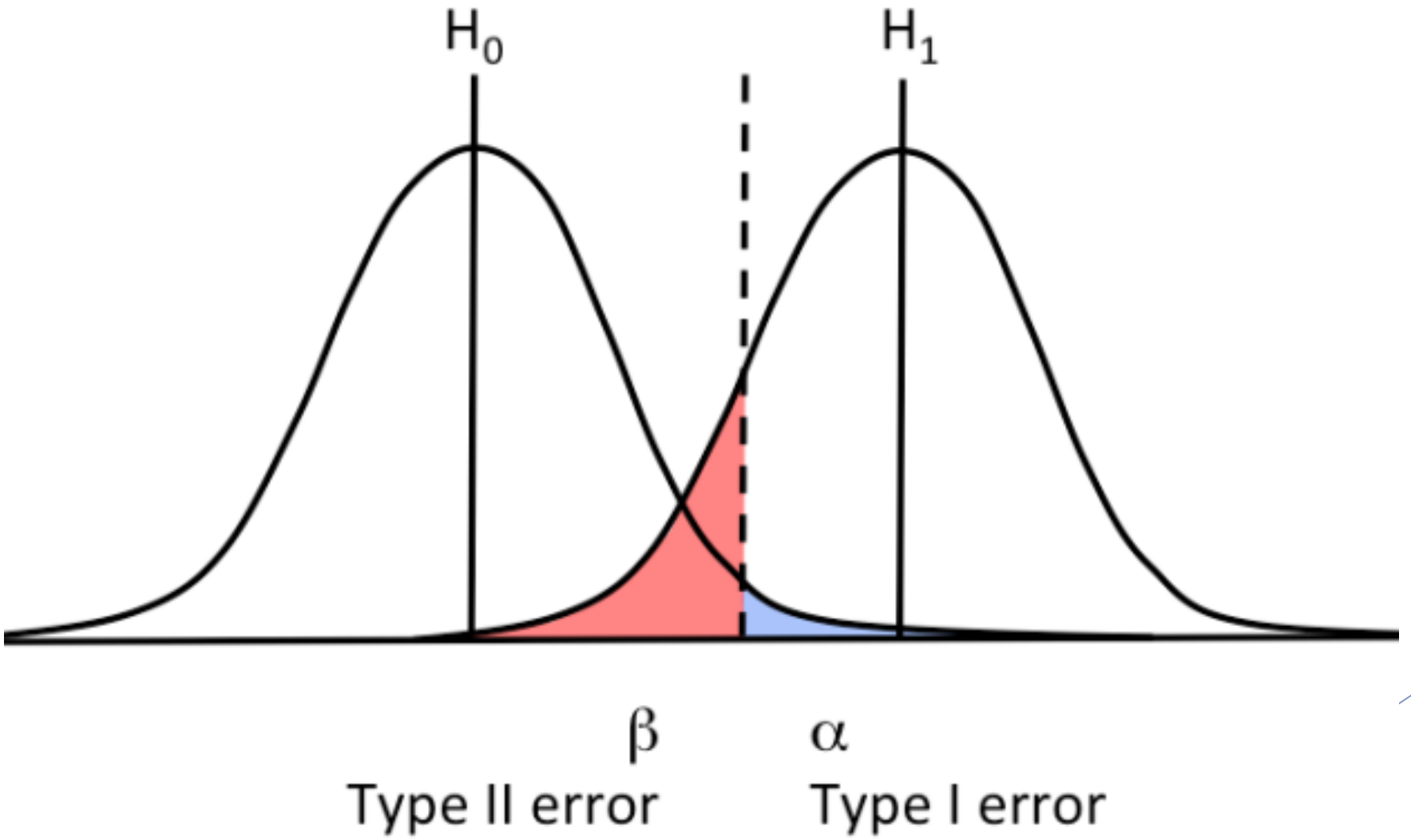
What a test aims for in terms of reliability and validity

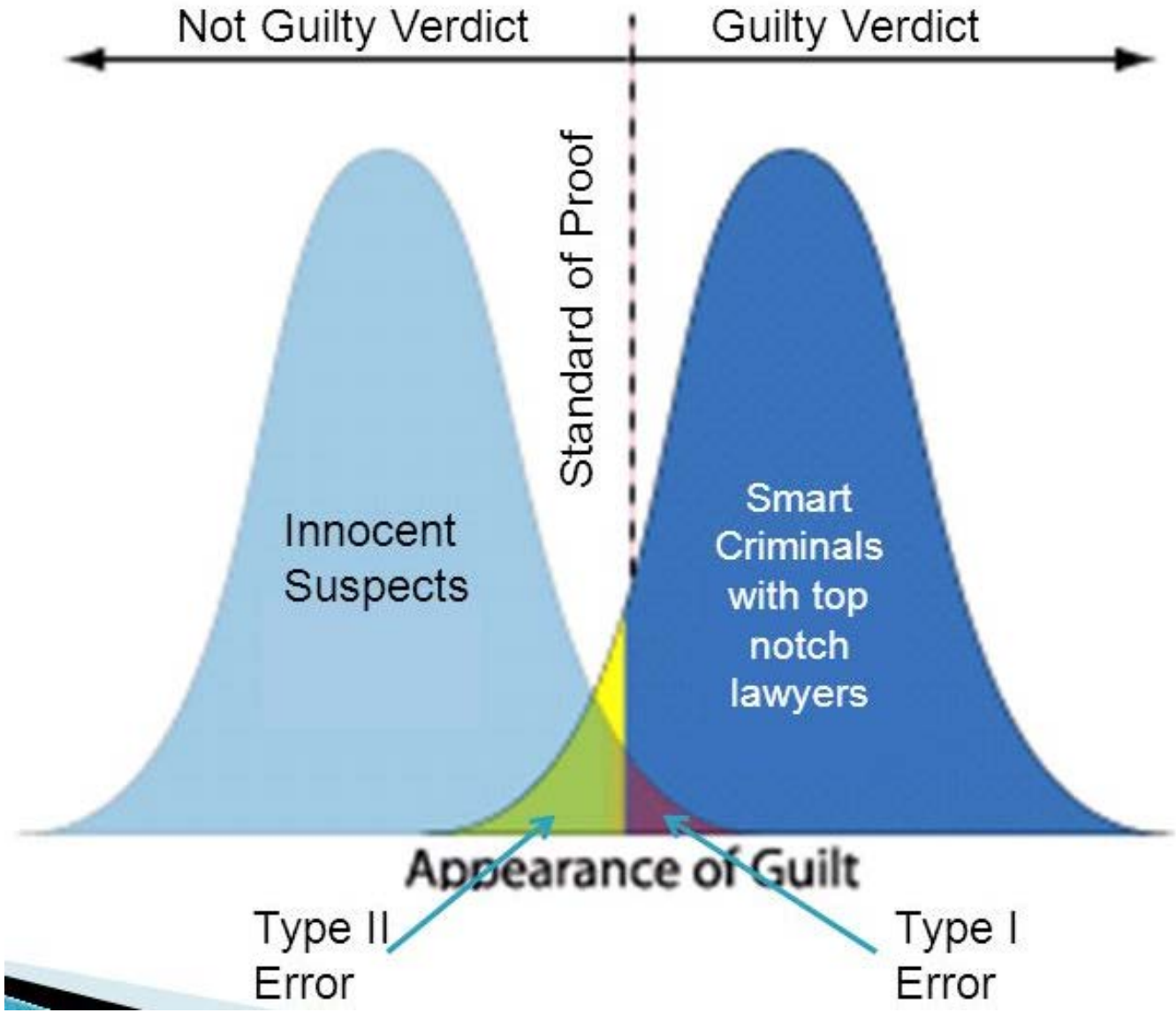


Reliable
Not valid

Questions?

Type I & II errors in continuous variables




Not Guilty Verdict
Guilty Verdict
Standard of Proof
Innocent Suspects
Smart Criminals with top notch lawyers
Appearance of Guilt
Type II Error
Type I Error