Diagnostic test evaluation with perfect reference test

Paolo Eusebi

16/09/2021

Four phases in architecture of diagnostic research

- **Phase I** Do test results in patients with the target disorder differ from those in normal people?
- **Phase II** Are patients with certain test results more likely to have the target disorder than patients with other test results?
- **Phase III** Does the test result distinguish patients with and without the target disorder among patients in whom it is clinically reasonable to suspect that the disease is present?
- **Phase IV** Do patients who undergo this diagnostic test fare better (in their ultimate health outcomes) than similar patients who are not tested?

Measures of diagnostic accuracy

	D+	D-
T+	TP	FP
T-	FN	TN

Measures of diagnostic accuracy

	D+	D-
T+	TP	FP
T-	FN	TN

- Sensitivity $= \mathrm{TP}/\mathrm{D}+$
- Specificity $= \mathrm{TN}/\mathrm{D}-$
- PPV $= \mathrm{TP}/\mathrm{T}+$
- NPV $= \mathrm{TN}/\mathrm{T}-$

Measures of diagnostic accuracy

- Sensitivity and specificity do not depend on the disease prevalence.
- PPV and NPV depend on the sensitivity, specificity, and the disease prevalence.

$$PPV = \frac{Se \cdot p}{Se \cdot p + (1 - Sp) \cdot (1 - p)}$$

$$NPV = \frac{Sp \cdot (1 - p)}{(1 - Se) \cdot p + Sp \cdot (1 - p)}$$

Measures of diagnostic accuracy

- Frequencies

	D+	D-
T+	y[1]	y[3]
T-	y[2]	y[4]

- Probabilities

	D+	D-
T+	prob[1]	prob[3]
T-	prob[2]	prob[4]

- Prevalence = prob[1]+prob[2]

Bayesian model

```
"model {

# likelihood
  y[1:4] ~ dmulti(prob[1:4], n)

  prob[1] <- p * Se
  prob[2] <- p * (1 - Se)
  prob[3] <- (1 - p) * (1 - Sp)
  prob[4] <- (1 - p) * Sp

# priors
  p ~ dbeta(1, 1)
  Se ~ dbeta(1,1)
  Sp ~ dbeta(1,1)
"
```

Bayesian model

Let's code!