Lecture 23 Introduction To Hypothesis Testing

BIO210 Biostatistics

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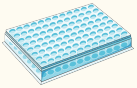
LIFE SCIENCES

Estimation



Population parameters	**Sample**	
Parameters	Point estimate	Interval estimate (95% CI)
μ	$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$	$\bar{x} \pm Z_{\alpha/2}\frac{\sigma}{\sqrt{n}}$ $\quad \bar{x} \pm t_{\alpha/2,n-1}\frac{s}{\sqrt{n}}$
σ^2	$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x-\bar{x})^2$	$\left(\frac{(n-1)s^2}{\chi^2_{0.025,n-1}}, \frac{(n-1)s^2}{\chi^2_{0.975,n-1}}\right)$
π	$p = \frac{m}{n}$	$p \pm Z_{\alpha/2}\sqrt{\frac{p(1-p)}{n}}$

ABO Blood Type Distribution

Clinical Infectious Diseases

BRIEF REPORT

Relationship Between the ABO Blood Group and the Coronavirus Disease 2019 (COVID-19) Susceptibility

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ABO Blood Type Distribution In COVID-19 Patients

The ABO blood group distribution in 1,775 COVID-19 patients from Wuhan Jinyintan Hospital:

Total		A	B	AB	O
Number	$1,775$	670	469	178	458
Proportion	1	0.38	0.26	0.1	0.26

ABO Blood Type Distribution

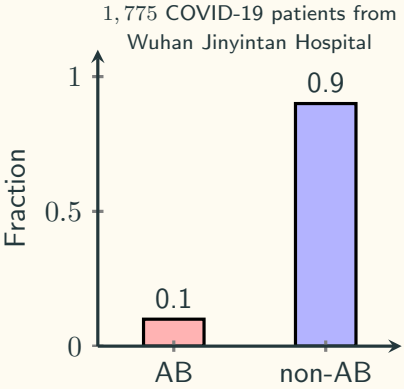
- **Question 1:** what is the proportion of blood type AB in the COVID-19 patients ?

✓ Estimations from the random sample: point (0.1) and interval $(95\%$ CI: $0.083 - 0.117)$.

- **Question 2:** ask questions by incorporating the previous knowledge.

From "ABO blood types distribution in Han Chinese" by Deren Peng in 1992. Data from Hubei:

Total	A	B	AB	O
1	0.32	0.25	0.09	0.34



Blood Type AB In COVID-19 Patients

- **Question 2:** is the proportion of blood type AB in the COVID-19 patients different from 0.09?

✓ If the proportion of blood type AB in the COVID-19 patients were 0.09, the probability of observing the proportion of blood type AB in $1,775$ COVID-19 patients is 0.1 would be ... ?

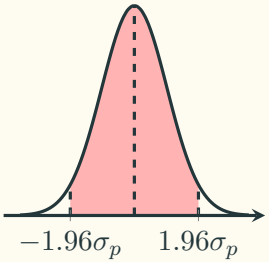
- Using binomial probability ($n = 1775,\ p = 0.09$):

$$P(\boldsymbol{X} = 178) = \binom{1775}{178} 0.09^{178} 0.91^{1597} = 0.01$$

- Using the sampling distribution of the proportion:

$$Z = \frac{p - \pi}{\sqrt{\frac{\pi(1-\pi)}{n}}} = \frac{0.1 - 0.09}{\sqrt{\frac{0.09 \times 0.91}{1775}}} = 1.47$$

$\mu_p = 0.09,\ \sigma_p = 0.008$



Blood Type A COVID-19 Patients

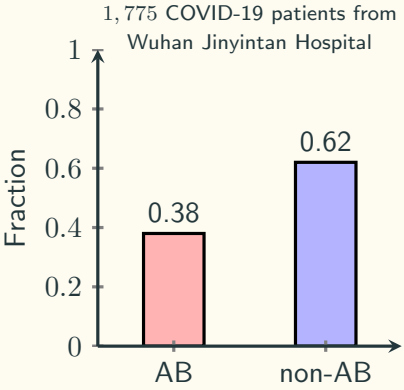
- **Question 1:** what is the proportion of blood type A in the COVID-19 patients ?

✓ Estimations from the random sample: point (0.38) and interval $(95\%$ CI: $0.352 - 0.408)$.

- **Question 2:** ask questions by incorporating the previous knowledge.

From "ABO blood types distribution in Han Chinese" by Deren Peng in 1992. Data from Hubei:

Total	A	B	AB	O
1	0.32	0.25	0.09	0.34



Blood Type A COVID-19 Patients

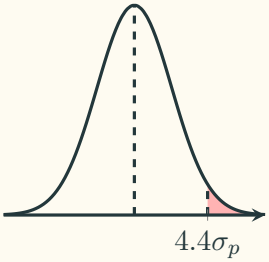
- **Question 2:** is the proportion of blood type A in the COVID-19 patients higher than 0.32?

✓ If the proportion of blood type A in the COVID-19 patients were less or equal to 0.32, the probability of observing the proportion of blood type A in $1,175$ COVID-19 patients is 0.38 would be ... ?

$$\mu_p = 0.32,\ \sigma_p = 0.014$$

- Using the sampling distribution of the proportion:

$$Z = \frac{p - \pi}{\sqrt{\frac{\pi(1-\pi)}{n}}} \geqslant \frac{0.38 - 0.32}{\sqrt{\frac{0.32 \times 0.68}{1775}}} = 4.4$$



Measuring Body Temperature

Human Body Temperature

In 1868: the German physician Carl Reinhold August Wunderlich concluded that the average body temperature of normal people was 37.0 °C (1 million readings from around $25,000$ people).

- How is the body temperature measured?
  - In the rectum (rectal temperature)
  - In the mouth (oral temperature)
  - Under the arm (axillary temperature)
  - In the ear (tympanic temperature)
  - On the skin of the forehead over the temporal artery
- In 1992, Mackowiak *et al.* JAMA (36.8 °C).

Human Body Temperature

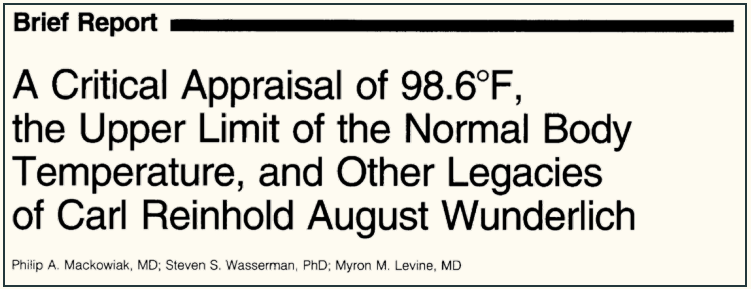
- **Question 1:** what is the mean body temperature of normal people ?

✓ Estimations from a random sample: point and interval.

- **Question 2:** is the mean body temperature of normal people really 37 °C ?

✓ If the mean body temperature of normal people were 37 °C, then we would expect to see ... with a probability of ...

Human Body Temperature



Brief Report

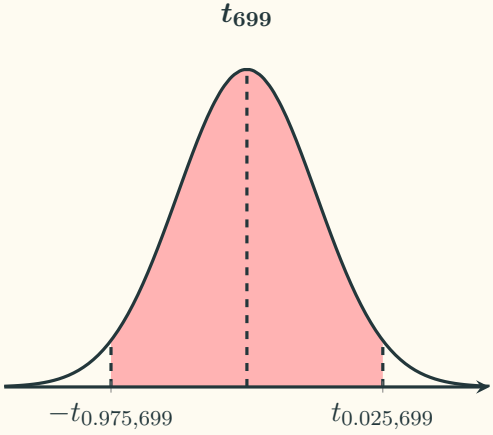
A Critical Appraisal of 98.6°F, the Upper Limit of the Normal Body Temperature, and Other Legacies of Carl Reinhold August Wunderlich

Philip A. Mackowiak, MD; Steven S. Wasserman, PhD; Myron M. Levine, MD

- Mackowiak $et\ al.$ JAMA 268: 1578 - 80.
  - A random sample with 700 temperature readings.
  - Mean: 36.8 °C.
  - Standard deviation: 0.4 °C.

How to assess: If the mean body temperature of normal people were 37 °C (μ), the probability of observing 700 temperature readings with a mean of 36.8 °C ($\bar{x}$) or more extreme is ?

Human Body Temperature



$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}} = \frac{36.8 - 37}{\frac{0.4}{\sqrt{700}}} = -12.23$$

Probability vs. Statistics