Moderna COVID19 efficacy data

Published sources.

Acording to CNN: "In Moderna's trial, 15,000 study participants were given a placebo, which is a shot of saline that has no effect. Over several months, 90 of them developed Covid-19, with 11 developing severe forms of the disease. Another 15,000 participants were given the vaccine, and only five of them developed Covid-19. None of the five became severely ill."

Denote by

$$X_1, \ldots, X_n \sim \text{Bernoulli}(p_C)$$

$n = 15,000$, the random variables indicating whether or not an individual who received the placebo treatment develops COVID-19 in a given period. The data suggests that a reasonable estimator of p_C is

$$\widehat{p}_C = \frac{90}{15000} = 0.006 \, ,$$

or 60 in 10000.

Denote by

$$Y_1, \ldots, Y_n \sim \text{Bernoulli}(p_T) \, ,$$

$n = 15,000$, the random variables indicating whether or not an individual who received the Moderna vaccine develops COVID-19 in a given period. The data suggests that a reasonable estimator of p_T is

$$\widehat{p}_T = \frac{5}{15000} = 0.0003 \, ,$$

or 3 in 10000.

Treatment efficacy is defined as

$$\text{Tx}_E = \frac{p_C - p_T}{p_C} = 1 - \frac{p_T}{p_C}$$

which is 1 minus the relative risk of infection. An estimator of the treatment efficacy is

$$\widehat{\text{Tx}}_E = 1 - \frac{\widehat{p}_T}{\widehat{p}_C} = 1 - \frac{5/15000}{90/15000} = 1 - \frac{5}{90} = 0.944$$

or 94.4%.

We focus on constructing a confidence interval for $\frac{p_T}{p_C}$. The log relative risk estimator is $\log(\widehat{p}_T/\widehat{p}_C) = \log(5/90) = -2.89$. The standard error for the log relative risk is (see lecture 19 in Biostatistics 652)

$$\widehat{\text{SE}}_{\log RR} = \left\{ \frac{1 - \widehat{p}_C}{\widehat{p}_C n_C} + \frac{1 - \widehat{p}_T}{\widehat{p}_T n_T} \right\}^{1/2}$$

```
estpc=90/15000
estpt=5/15000
nc=15000
nt=15000

logrr=log(estpt/estpc)
selogrr=sqrt((1-estpc)/(estpc*nc)+(1-estpt)/(estpt*nt))
```

Thus, the 95% CI based on the Normal approximation for the log relative risk is

```
logrr+1.96*c(-1,1)*selogrr
```

```
## [1] -3.790645 -1.990098
```

The 95% CI based on the Normal approximation for the relative risk is

```
exp(logrr+1.96*c(-1,1)*selogrr)
```

```
## [1] 0.02258103 0.13668198
```

and the 95% CI based on the Normal approximation for the treatment efficacy is

```
round(1-exp(logrr+1.96*c(1,-1)*selogrr),digits=2)
```

```
## [1] 0.86 0.98
```