

# Practical assignment trial-based cost-effectiveness analysis

X. Pouwels

2021-07-28

```
rm(list = ls()) # clear environment
options(scipen = 999) # Disable scientific notations
library(tidyverse)

## -- Attaching packages ----- tidyverse 1.3.0 --

## v ggplot2 3.3.3      v purrr  0.3.4
## v tibble  3.0.5      v dplyr  1.0.3
## v tidyr   1.1.2      v stringr 1.4.0
## v readr   1.4.0      v forcats 0.5.1

## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()

library(knitr)
library(boot)

load(file = "trial_based_CEA.RData")
```

## Aim

The aim of this practical assignment is to perform a health economic analysis using data collected during a clinical trials. The data used in this assignment was obtained during a randomised controlled trial (RCT) comparing two interventions for treating esophageal cancer. In total, 200 patients were randomized between usual care (open transthoracic esophagectomy) and the new intervention (robot-assisted thoraco-laparoscopic esophagectomy). For each patient, data was collected on the time required for the procedure in the operating room, the occurrence of complications, the length of stay in the hospital, and the quality of life after the procedure. In addition, data on the cost of resources was collected from the literature.

## Instructions

1. Download the folder `Practical_Trial_based_CEA` from the Canvas page and save it on your computer
2. Open the `Assingment.R` file
3. Load the data for this assignment (`trial_based_CEA.RData`) using the `load()` function

4. When loaded, 8 objects (1 data frame, `df`, and 7 values) should appear in your environment
5. When performing the assignment, please document your code (using R markdown for instance)
6. Please keep your answers for the discussion

## Objects

### `df`

This dataframe contains 9 variables, each row of the dataframe contains the data from one participant:

- `ID` = Participant ID
- `Procedure` = Group to which the participant belongs; 1 = usual care (open transthoracic esophagectomy, 2 = the new intervention (robot-assisted thoraco-laparoscopic esophagectomy)
- `OR_time` = Operating time, in minutes
- `Major_compl` = ‘Did the participant experience a major complication?’; 1 = yes, 0 = no
- `Minor_compl` = ‘Did the participant experience a minor complication?’; 1 = yes, 0 = no
- `Length_icu` = Length of stay at the intensive care unit (ICU) in days
- `Length_mcu` = Length of stay at the intensive care unit (MCU) in days
- `Death` = ‘Did the participant experience die at the hospital?’; 1 = yes, 0 = no
- `Qol` = Quality of life of the participant after the procedure

### other objects

- `c_Open` = costs of the open surgery (usual care)
- `c_Robot` = costs of the new intervention (robot-assisted thoraco-laparoscopic esophagectomy)
- `c_ICU_day` = costs of one day at the ICU
- `c_MCU_day` = costs of one day at the MCU
- `c_Major_compl` = costs of a major complication
- `c_Minor_compl` = costs of a minor complication
- `c_OK_hour` = costs of operating in the OK, per hour

## Assignment and questions

1. Calculate the mean operating time, risk of complications, length of stay at ICU and MCU, risk of death, and quality of life after procedure, for both trial arms. *Hint: use the functions `group_by` and `summarise` from the `tidyverse` package to do so.*

```
res_health <- df %>%
  group_by(Procedure) %>%
  summarise(mean_OR_time = mean(OR_time),
            mean_Major_compl = mean(Major_compl),
            mean_Minor_compl = mean(Minor_compl),
            mean_Length_icu = mean(Length_icu),
            mean_Length_mcu = mean(Length_mcu),
            mean_p_death = mean(Death),
            mean_Qol = mean(Qol))

kable(t(res_health),
      digits = 2,
      caption = "Mean health outcome per group")
```

Table 1: Mean health outcome per group

	1	2
Procedure	1.00	2.00
mean_OR_time	139.56	122.22
mean_Major_compl	0.26	0.14
mean_Minor_compl	0.31	0.50
mean_Length_icu	1.33	1.20
mean_Length_mcu	13.67	15.36
mean_p_death	0.18	0.13
mean_Qol	0.41	0.48

- 1.a. Which treatment provides the best health outcomes?

The new intervention (robot-assisted surgery) provides better health outcomes because it results in a higher utility than usual care (0.480181846203199 versus 0.410040233913325).

- 1.b. Is robot-assisted surgery an improvement upon usual care with respect to all outcomes?

No, robot-assisted surgery leads to an increase in the number of minor complications (0.5 versus 0.31) and the length of stay at the medium care unit (15.36 versus 13.67).

2. Create three new variables in `df` called `Cost_procedure`, `Cost_compl`, `Cost_hosp`, which respectively contain the costs related to the procedure (operatime time + procedure), the costs related to complications, and the costs related to hospitalization for each participant. To do so, use the objects beginning with `c_`. *Hint: Multiply the column of the dataframe `df` by the corresponding objects.*

```
# Calculate total costs for each category per participant
df$Cost_procedure <- ifelse(df$Procedure == 1, c_Open + df$OR_time / 60 * c_OK_hour, c_Robot + df$OR_time)
df$Cost_compl      <- df$Major_compl * c_Major_Compl + df$Minor_compl * c_Minor_Compl
df$Cost_hosp       <- df$Length_icu * c_ICU_day + df$Length_mcu * c_MCU_day

kable(rbind(df[,2:ncol(df)] %>%
  filter(Procedure == 1) %>%
  head(5),
```

```
df[,2:ncol(df)] %>%
  filter(Procedure == 2) %>%
  head(5)
),
digits = 2,
caption = "First rows of cost per participant")
```

Table 2: First rows of cost per participant

Procedure	OR_time	Major_comp	Minor_comp	length_icu	length_hosp	Death	Qol	Cost_procedure	Cost_compl	Cost_hosp
1	129.63	0	0	6	8	0	0.55	3080.29	0	11900
1	146.15	0	1	0	13	0	0.84	3217.94	1500	7150
1	154.73	1	0	0	19	0	0.09	3289.41	10000	10450
1	133.17	0	0	6	16	0	0.79	3109.78	0	16300
1	133.98	0	1	0	11	0	0.55	3116.51	1500	6050
2	116.34	0	1	0	14	1	0.00	4469.48	1500	7700
2	154.09	0	0	0	20	0	0.15	4784.09	0	11000
2	150.41	0	0	0	15	1	0.00	4753.45	0	8250
2	127.05	1	1	5	15	0	0.99	4558.75	11500	14500
2	168.03	0	1	0	21	0	1.00	4900.29	1500	11550

3. Create a new variable in `df` called `Total_costs`, which contains the total costs per participant. Calculate the mean costs per group. Based on this information:

```
# Calculate total costs per participant
df$Total_costs <- df$Cost_procedure + df$Cost_compl + df$Cost_hosp

res_costs <- df %>%
  group_by(Procedure) %>%
  summarise(mean_tot_costs = mean(Total_costs))

kable(res_costs,
  digits = 0,
  caption = "Mean total costs per group")
```

Table 3: Mean total costs per group

Procedure	mean_tot_costs
1	15409
2	16617

3.a. Which treatment is cheaper on average, given the observed trial data?

**Answer:** 3.b. What do you think is the probability that the new intervention is cheaper?

**Answer:** This question is hard to answer, all we know is that some patients in the intervention arm have lower cost than some patients in the usual care arm. On average the intervention is more expensive so we would guess that this probability is less than 50% but we don't know yet.

3.c. What do you think is the probability that the new intervention leads to health gain?

**Answer:** This question is also hard to answer. On average the intervention is leads to a substantially higher utility than usual care, so we would guess that this probability is greater than 50% but we don't know yet.

4. Calculate the difference in mean quality of life and mean total costs between the new intervention and usual care (i.e. the incremental effects and incremental costs). Calculate the ICER using this information. *Hint: use the results you obtained in previous steps.*

```
Inc_qol <- res_health[2, "mean_Qol"] - res_health[1, "mean_Qol"]
Inc_costs <- res_costs[2, "mean_tot_costs"] - res_costs[1, "mean_tot_costs"]
ICER <- Inc_costs / Inc_qol

c(Inc_qol, Inc_costs, ICER) # show results
```

```
## $mean_Qol
## [1] 0.07014161
##
## $mean_tot_costs
## [1] 1207.539
##
## $mean_tot_costs
## [1] 17215.73
```

```
write.csv(df, "df_shiny.csv")
```

5. Save your dataframe `df` as a .csv file, and upload it in the R Shiny app to perform bootstrapping.
6. Open the R shiny app using the following command in R and follow the instructions.