

Survival Analysis for the VQI FBVAR Dataset

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Variables to adjust for

In the unadjusted model, we studied only the differences in the outcomes:

- comparing **PRESENTATION**

In the adjusted models, we also:

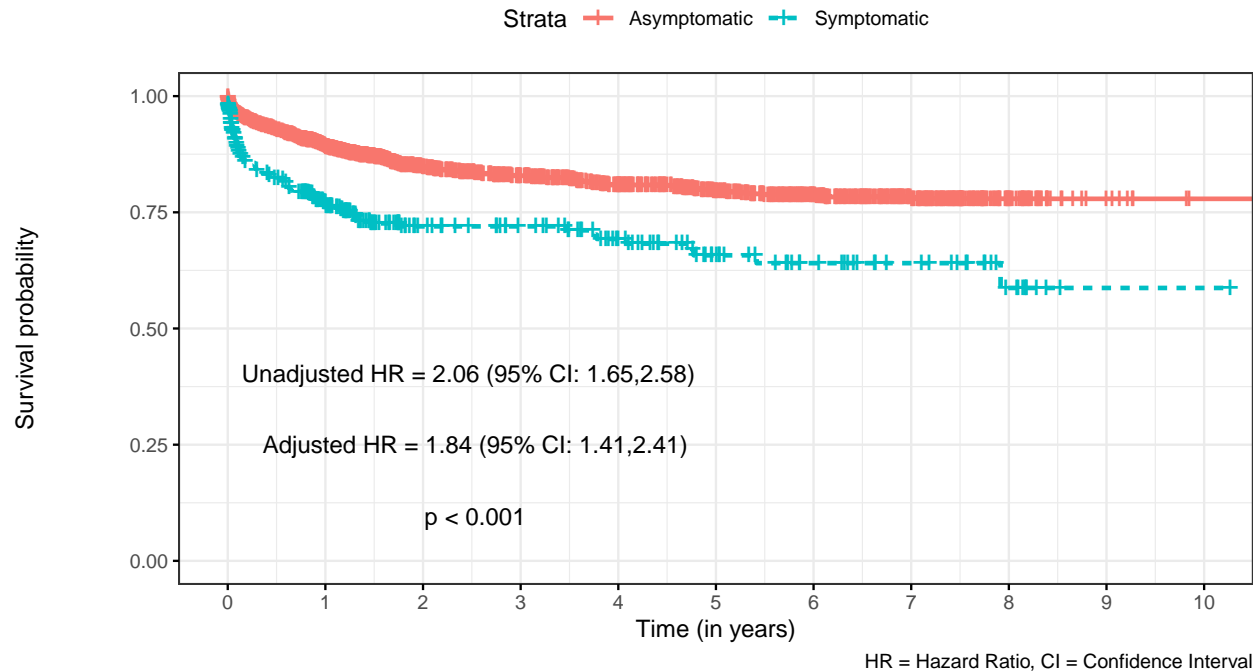
- cluster on **CENTERID**
- adjust for **AGECAT**, **GENDER**, **PREOP_SMOKING**, **PRIOR_AORSURG**, **PRIOR_CHF**, **PREOP_DIALYSIS**
- adjust for **PATHOLOGY**, **extent**
- primary outcome: All-cause mortality
- secondary outcome: Time-to-first reintervention for patients with long-term follow-up

For the outcomes described below, Kaplan-Meier curves were produced grouped by presentation, asymptomatic and symptomatic.

For the primary outcome only, we fitted a univariate Cox proportional hazards model and a multivariate stratified Cox proportional hazards model stratifying on sex.

*To fit the models, we merge groups for the **extent**: merge “Juxtarenal AAA” with “Type 4 TAAA”; “Type 1 TAAA”, “Type 2 TAAA”, “Type 3 TAAA”, with “Type 5 TAAA”. Now **extent** is a binary variable, Juxtarenal or not.*

Primary Outcome: All-Cause Mortality



Number at risk		Time (in years)										
Strata	Asymptomatic	3314	1849	984	802	631	472	339	208	60	8	1
	Symptomatic	442	199	105	90	69	45	31	22	10	1	1

Due to violating the proportional-hazards assumption, the multivariate Cox proportional-hazards model was stratified on sex to resolve this issue.

All-Cause Mortality			
Characteristic	HR ¹	95% CI ¹	p-value
PRESENTATION			
Asymptomatic	—	—	
Symptomatic	2.06	1.65, 2.58	<0.001

¹HR = Hazard Ratio, CI = Confidence Interval

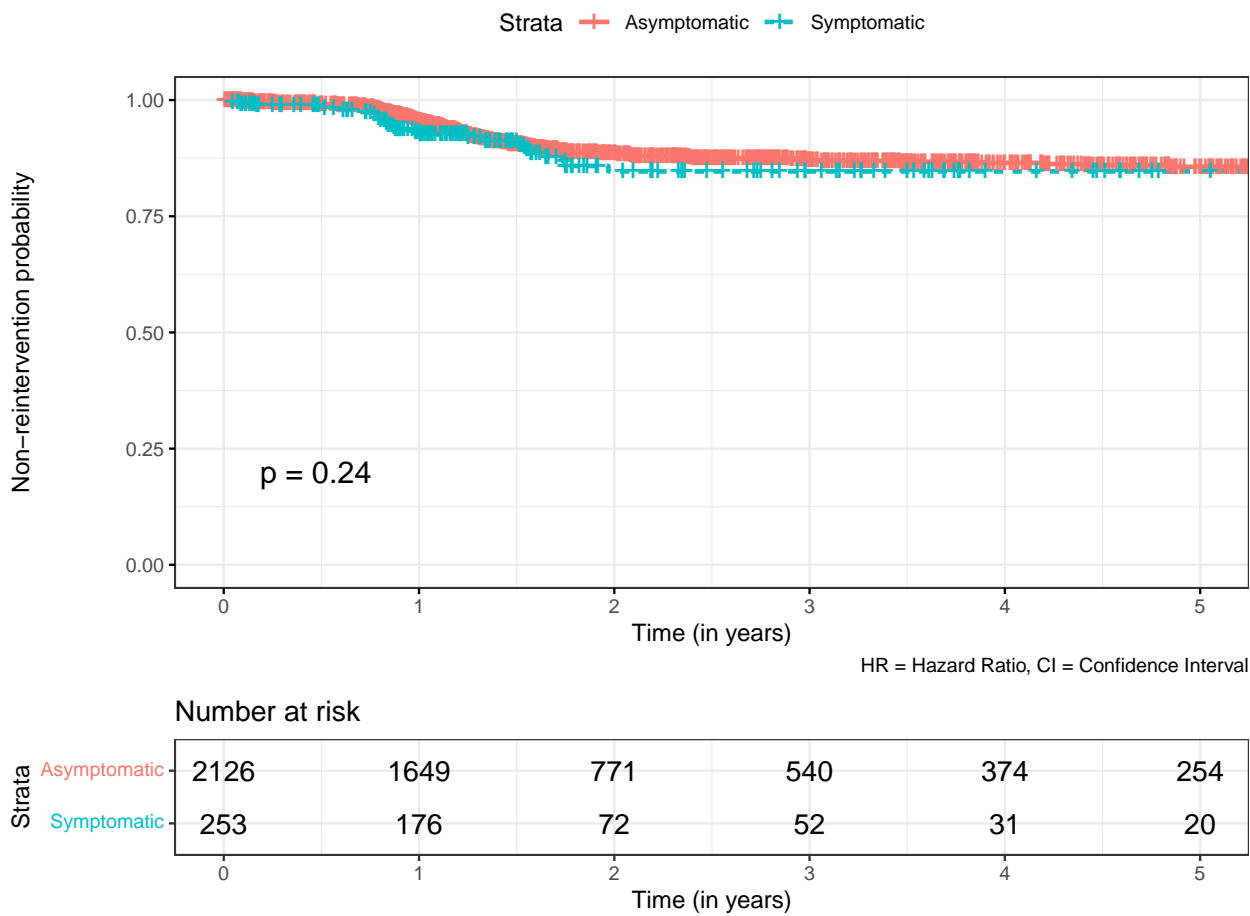
All-Cause Mortality			
Characteristic	HR ¹	95% CI ¹	p-value
PRESENTATION			
Asymptomatic	—	—	
Symptomatic	1.84	1.41, 2.41	<0.001

¹HR = Hazard Ratio, CI = Confidence Interval

Characteristic	All-Cause Mortality		
	HR ¹	95% CI ¹	p-value
AGECAT			
<50	—	—	
>79	2.18	0.52, 9.12	0.28
50-59	2.30	0.57, 9.24	0.24
60-69	1.42	0.36, 5.56	0.61
70-79	2.02	0.50, 8.25	0.33
PREOP_SMOKING			
No	—	—	
Yes	1.12	0.85, 1.48	0.42
PRIOR_AORSURG			
Both	—	—	
Endo	0.90	0.50, 1.62	0.72
None	0.59	0.36, 0.98	0.040
Open	0.63	0.34, 1.16	0.14
PRIOR_CHF			
No	—	—	
Yes	1.57	1.32, 1.87	<0.001
PREOP_DIALYSIS			
No	—	—	
Yes	1.61	1.00, 2.58	0.050
PATHOLOGY			
Aneurysm	—	—	
Aneurysm from dissection	0.52	0.31, 0.87	0.013
Dissection	0.49	0.20, 1.19	0.12
PAU/IMH	1.00	0.37, 2.73	>0.99
extent			
Juxtarenal	—	—	
No	1.39	1.10, 1.76	0.006

¹HR = Hazard Ratio, CI = Confidence Interval

Secondary Outcome: Long-term Follow-up First Reintervention (time-to-event outcome)



Code Appendix

```
knitr::opts_chunk$set(echo = FALSE,message = FALSE,warning = FALSE)
knitr::opts_chunk$set(fig.width=20, fig.height=20)

library(tidyverse)
library(survival)
library(survminer)
library(knitr)
library(kableExtra)
library(gtsummary)
library(flextable)

## ----- working directories for Lily -----
wd_lily = '/Users/hanyiwang/Desktop/Comparative-analysis-of-treatments-of-CAA'
path_lily = c("../data/FBVAR.csv")

## ----- working directories for Jenn -----
# wd_jenn =
# path_jenn =

## ----- working directories for Thu -----
wd_thu = '/Users/thuvu/Desktop/Comparative-analysis-of-treatments-of-CAA'
path_thu = c("TEVAR_PROC.csv")
path_thu1 = c("LT 2.csv")

## ----- read data -----
# setwd(wd_lily)
# FBVAR = read.csv(path_lily)

# setwd(wd_jenn)
# FBVAR = read.csv(path_jenn)

setwd(wd_thu)
TEVAR_PROC1 = read.csv(path_thu)
LTF = read.csv(path_thu1)

### Primary Outcome: All-Cause Mortality
# omitting patients with negative survival days
TEVAR_PROC <- subset(TEVAR_PROC1, PROC_SURVIVALDAYS>=0)

# create survival object, time-to-event
# converted days to years
tte <- TEVAR_PROC %>% with(Surv(PROC_SURVIVALDAYS/365, DEAD))

# compute survival curves
fit <- survfit(tte ~ PRESENTATION, data=TEVAR_PROC)

# plotting KM curves
ggsurv <- ggsurvplot(fit,
  risk.table = TRUE,
  linetype = "strata",
```

```

    surv.median.line = "hv",
    ggtheme = theme_bw(),
    xlab = "Time (in years)",
    legend.labs = c("Asymptomatic", "Symptomatic"),
    break.time.by=1,
    caption="HR = Hazard Ratio, CI = Confidence Interval")

ggsurv$plot <- ggsurv$plot +
  annotate(
    "text",
    x = 2.5, y = 0.25,
    label = "Unadjusted HR = 2.06 (95% CI: 1.65,2.58)
\n Adjusted HR = 1.84 (95% CI: 1.41,2.41)
\n p < 0.001",
    size = 4
  )

ggsurv

# changing extent into a binary variable
TEVAR_PROC = TEVAR_PROC %>%
  mutate(extent = factor(extent, levels = c("Juxtarenal AAA", "Type 1 TAAA", "Type 2 TAAA",
    "Type 3 TAAA", "Type 4 TAAA", "Type 5 TAAA"),
    labels = c('Juxtarenal', 'No', 'No', 'No', 'Juxtarenal', 'No'))

# Unadjusted survival model
mod.cox1 <- coxph(tte ~ PRESENTATION, data=TEVAR_PROC)

# Adjusted survival model
mod.cox2 <- coxph(tte ~ PRESENTATION + cluster(CENTERID) + AGE CAT + strata(GENDER) +
  PREOP_SMOKING + PRIOR_AORSURG + PRIOR_CHF +
  PREOP_DIALYSIS + PATHOLOGY + extent ,
  data=TEVAR_PROC)

t1 <- mod.cox1 %>%
  tbl_regression(exponentiate = TRUE,
    tidy_fun = broom.mixed::tidy,
    pvalue_fun = function(x) style_pvalue(x, digits = 2)) %>%
  bold_p(t = 0.05)
tbl_merge(tbls = list(t1), tab_spanner = "**All-Cause Mortality**") %>%
  as_flex_table()

t2 <- mod.cox2 %>%
  tbl_regression(exponentiate = TRUE,
    tidy_fun = broom.mixed::tidy,
    pvalue_fun = function(x) style_pvalue(x, digits = 2)) %>%
  bold_p(t = 0.05)
tbl_merge(tbls = list(t2), tab_spanner = "**All-Cause Mortality**") %>%
  as_flex_table()

### Secondary Outcome: Long-term Follow-up First Reintervention
### (time-to-event outcome)
# filtering the LTF dataset to only include FEVAR procedures

```

```

t <- as.data.frame(table(TEVAR_PROC1$PRIMPROCID))
LTF_merge <- LTF[LTF$PRIMPROCID %in% t$Var1,]

# replacing all missing in number of reinterventions with 0
LTF_merge$total_reint[is.na(LTF_merge$total_reint)] <- 0

# creating event variable, binary re-intervention
# 1 = had at least 1 reintervention, 0 = had 0 reinterventions
LTF_merge$retx_bin <- ifelse(LTF_merge$total_reint>=1, 1, 0)
# creating time variable (in days)
LTF_merge$time <- ifelse(LTF_merge$retx_bin==1,
                        LTF_merge$first_reint_time, LTF_merge$new_surv)

# omitting patients with negative survival days
LTF_merge <- subset(LTF_merge, time>=0)

# merging proc and ltf datasets on procedure ID
LTF_comb <- merge(LTF_merge, TEVAR_PROC1, by = "PRIMPROCID")

# create survival object, time-to-event
# converted days to years
tte1 <- LTF_comb %>% with(Surv(time/365, retx_bin))

# compute survival curves
fit1 <- survfit(tte1~PRESENTATION, data=LTF_comb)

# plotting KM curves
ggsurvplot(
  fit1,
  pval = TRUE,
  risk.table = TRUE,
  linetype = "strata",
  ggtheme = theme_bw(),
  legend.labs = c("Asymptomatic", "Symptomatic"),
  xlab = "Time (in years)",
  ylab = "Non-reintervention probability",
  break.time.by = 1,
  xlim = c(0,5),
  caption = "HR = Hazard Ratio, CI = Confidence Interval"
)

```