

Survival Analysis Project, Burned Victims Programmed

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11/13/2018

```
library(survival)
library(tidyverse)

## -- Attaching packages ----- tidyverse 1.2.1 --

## v ggplot2 3.0.0    v purrr  0.2.5
## v tibble  1.4.2    v dplyr  0.7.6
## v tidyr   0.8.1    v stringr 1.3.1
## v readr   1.1.1    v forcats 0.3.0

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

library(KMsurv)

#Exploratory Data Analysis
data("burn")
burn.dataset <- data("burn")

sum(burn$Z10) #number of patients with burn in throat

## [1] 45

mean(burn$Z4) #avg body burn percentage is 24.69481

## [1] 24.69481

summary(burn) #5 point summary for all variables #z4 would be good

##      Obs      Z1      Z2      Z3
## Min.   : 1.00  Min.   :0.0000  Min.   :0.0000  Min.   :0.0000
## 1st Qu.: 39.25  1st Qu.:0.0000  1st Qu.:0.0000  1st Qu.:1.0000
## Median : 77.50  Median :1.0000  Median :0.0000  Median :1.0000
## Mean   : 77.50  Mean   :0.5455  Mean   :0.2208  Mean   :0.8766
## 3rd Qu.:115.75  3rd Qu.:1.0000  3rd Qu.:0.0000  3rd Qu.:1.0000
## Max.   :154.00  Max.   :1.0000  Max.   :1.0000  Max.   :1.0000
##      Z4      Z5      Z6      Z7
## Min.   : 2.00  Min.   :0.0000  Min.   :0.0000  Min.   :0.0000
## 1st Qu.:12.25  1st Qu.:0.0000  1st Qu.:0.0000  1st Qu.:1.0000
## Median :20.00  Median :0.0000  Median :0.0000  Median :1.0000
## Mean   :24.69  Mean   :0.4545  Mean   :0.2273  Mean   :0.8442
## 3rd Qu.:30.00  3rd Qu.:1.0000  3rd Qu.:0.0000  3rd Qu.:1.0000
## Max.   :95.00  Max.   :1.0000  Max.   :1.0000  Max.   :1.0000
##      Z8      Z9      Z10     Z11
## Min.   :0.0000  Min.   :0.0000  Min.   :0.0000  Min.   :1.000
## 1st Qu.:0.0000  1st Qu.:0.0000  1st Qu.:0.0000  1st Qu.:4.000
## Median :0.0000  Median :0.0000  Median :0.0000  Median :4.000
## Mean   :0.4091  Mean   :0.3052  Mean   :0.2922  Mean   :3.519
## 3rd Qu.:1.0000  3rd Qu.:1.0000  3rd Qu.:1.0000  3rd Qu.:4.000
```

```
## Max. :1.0000 Max. :1.0000 Max. :1.0000 Max. :4.000
## T1 D1 T2 D2
## Min. : 1.00 Min. :0.0000 Min. : 1.00 Min. :0.0000
## 1st Qu.: 7.00 1st Qu.:0.0000 1st Qu.: 7.00 1st Qu.:0.0000
## Median :11.00 Median :1.0000 Median :12.00 Median :0.0000
## Mean :12.11 Mean :0.6429 Mean :16.59 Mean :0.4091
## 3rd Qu.:15.00 3rd Qu.:1.0000 3rd Qu.:22.00 3rd Qu.:1.0000
## Max. :49.00 Max. :1.0000 Max. :62.00 Max. :1.0000
## T3 D3
## Min. : 1.00 Min. :0.0000
## 1st Qu.:10.00 1st Qu.:0.0000
## Median :17.00 Median :0.0000
## Mean :21.80 Mean :0.3117
## 3rd Qu.:30.75 3rd Qu.:1.0000
## Max. :97.00 Max. :1.0000
```

```
sum(burn$Z2)
```

```
## [1] 34
```

```
bodilyburncount <- subset(burn, select=Z5:Z10) %>% colSums()
bodilyburncount #setting up for barplot
```

```
## Z5 Z6 Z7 Z8 Z9 Z10
## 70 35 130 63 47 45
```

```
barplot(bodilyburncount, col = "cadetblue1", ylab = "Number of Patients",
        xlab="Area of Burn Location",
        main="Bar Plot of Patient Burn Location",
        names.arg=c("Head", "Buttock", "Trunk", "Upper Leg", "Lower Leg", "Respiratory"))
```

Bar Plot of Patient Burn Location



```

sum(burn$Z1) #total patients with body cleansing

## [1] 84

#number of females in dataset
females.in.study <- sum(burn$Z2)

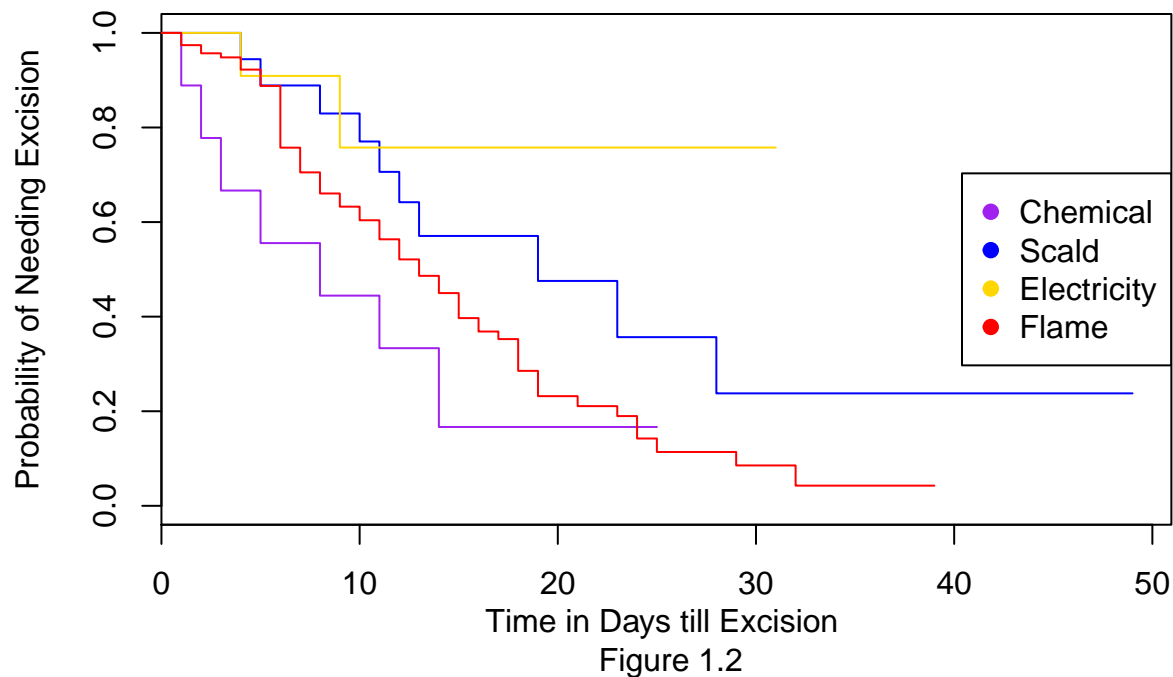
#Number of white people in group
sum(burn$Z3)

## [1] 135

# Z11 ( Type of Burn), Understanding nature of burn type through KM
Typeofburn.km <- survfit(Surv(burn$T1, burn$D1) ~ Z11, data = burn)
plot(Typeofburn.km, xlab = "Time in Days till Excision \n Figure 1.2", ylab = "Probability of Needing E",
legend("right", legend=c("Chemical", "Scald", "Electricity", "Flame"), col = c("purple", "blue", "gold", "red"))

```

Survival Rates Between Burn Type (Excision)



```

log.rank.test.typeofburn <- survdiff(Surv(T1, D1)~Z11, data = burn)
log.rank.test.typeofburn

```

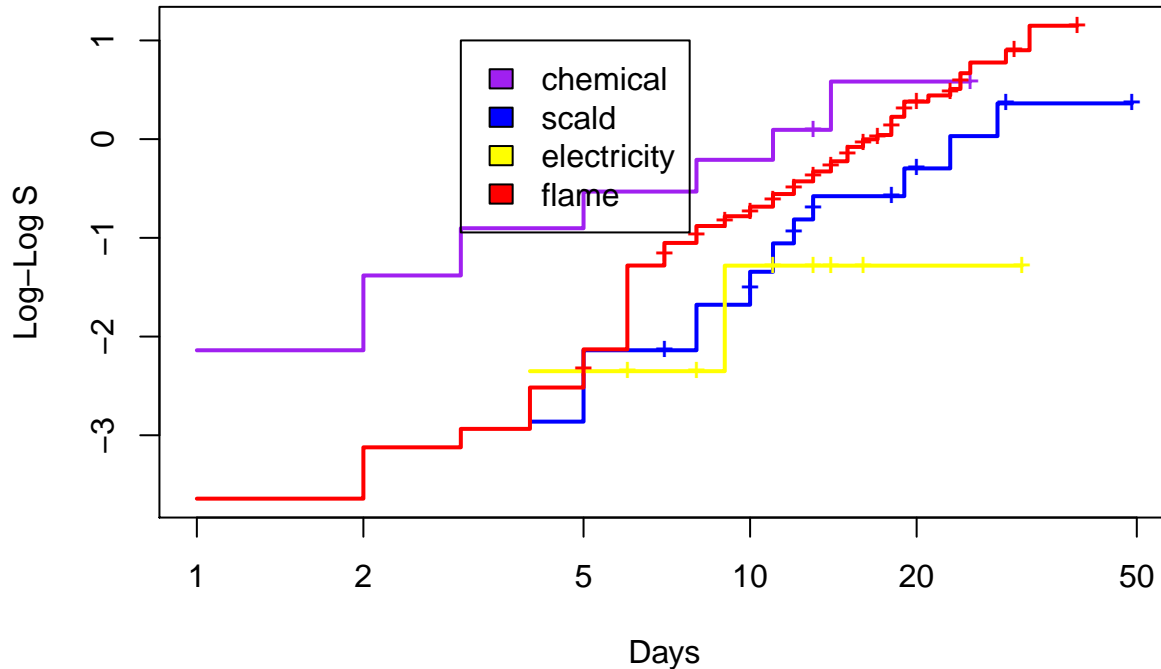
```

## Call:
## survdiff(formula = Surv(T1, D1) ~ Z11, data = burn)
##
##          N Observed Expected (O-E)^2/E (O-E)^2/V
## Z11=1    9         7      4.23    1.818    2.02
## Z11=2   18        10     15.71    2.077    2.67
## Z11=3   11         2      6.33    2.961    3.36
## Z11=4  116        80     72.73    0.727    2.95
##
## Chisq= 8.1  on 3 degrees of freedom, p= 0.04

```

```
plot(Typeofburn.km, mark="+",lwd=2,col = c("purple", "blue", "yellow", "red"), fun="cloglog", xlab="Days",
legend(3,1,c("chemical", "scald", "electricity", "flame"),fill=c("purple", "blue", "yellow", "red")) #c
```

log log plot on type of burn



```
#routine bathing vs chemical bathing effect
treatmentcoxph <- coxph(Surv(T2, D2)~Z1, data=burn)
treatmentcoxph
```

```
## Call:
## coxph(formula = Surv(T2, D2) ~ Z1, data = burn)
##
##      coef exp(coef) se(coef)      z    p
## Z1 0.691      1.996    0.268 2.58 0.01
##
## Likelihood ratio test=7.04  on 1 df, p=0.008
## n= 154, number of events= 63
```

```
summary(treatmentcoxph)
```

```
## Call:
## coxph(formula = Surv(T2, D2) ~ Z1, data = burn)
##
##      n= 154, number of events= 63
##
##      coef exp(coef) se(coef)      z Pr(>|z|)
## Z1 0.6913      1.9963    0.2683 2.577 0.00998 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##      exp(coef) exp(-coef) lower .95 upper .95
## Z1      1.996      0.5009      1.18      3.378
```

```
##
## Concordance= 0.585 (se = 0.035 )
## Rsquare= 0.045 (max possible= 0.977 )
## Likelihood ratio test= 7.04 on 1 df, p=0.008
## Wald test = 6.64 on 1 df, p=0.01
## Score (logrank) test = 6.9 on 1 df, p=0.009
```

#now checking under excision

```
treatmentcoxph2 <- coxph(Surv(T1, D1)~Z1, data=burn)
treatmentcoxph2
```

```
## Call:
## coxph(formula = Surv(T1, D1) ~ Z1, data = burn)
##
##      coef exp(coef) se(coef)      z      p
## Z1 0.550      1.734      0.207 2.66 0.0079
##
## Likelihood ratio test=7.24 on 1 df, p=0.007
## n= 154, number of events= 99
```

```
summary(treatmentcoxph2)
```

```
## Call:
## coxph(formula = Surv(T1, D1) ~ Z1, data = burn)
##
##      n= 154, number of events= 99
##
##      coef exp(coef) se(coef)      z Pr(>|z|)
## Z1 0.5504      1.7339      0.2072 2.656      0.0079 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##      exp(coef) exp(-coef) lower .95 upper .95
## Z1      1.734      0.5767      1.155      2.602
##
## Concordance= 0.599 (se = 0.03 )
## Rsquare= 0.046 (max possible= 0.996 )
## Likelihood ratio test= 7.24 on 1 df, p=0.007
## Wald test = 7.06 on 1 df, p=0.008
## Score (logrank) test = 7.23 on 1 df, p=0.007
```

#p-value of .008, reject the null hypothesis that no difference exists, thus we know that there is sign

#treatment group graph

```
treatmentgroups<- survfit(Surv(T2, D2)~Z1, data = burn)
summary(treatmentgroups)
```

```
## Call: survfit(formula = Surv(T2, D2) ~ Z1, data = burn)
##
##
##      Z1=0
##      time n.risk n.event survival std.err lower 95% CI upper 95% CI
##      1      70      2      0.971  0.0199      0.933      1.000
##      2      68      1      0.957  0.0242      0.911      1.000
##      3      67      2      0.929  0.0308      0.870      0.991
##      4      65      2      0.900  0.0359      0.832      0.973
##      5      62      3      0.856  0.0420      0.778      0.943
```

##	6	58	1	0.842	0.0438	0.760	0.932
##	8	54	3	0.795	0.0490	0.704	0.897
##	11	44	1	0.777	0.0511	0.683	0.884
##	16	36	1	0.755	0.0541	0.656	0.869
##	17	32	1	0.732	0.0573	0.628	0.853
##	20	29	1	0.706	0.0606	0.597	0.836
##	21	28	1	0.681	0.0635	0.567	0.818
##	22	26	1	0.655	0.0662	0.537	0.799
##	24	24	1	0.628	0.0689	0.506	0.778

Z1=1							
##	time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
##	1	84	4	0.952	0.0232	0.908	0.999
##	2	80	4	0.905	0.0320	0.844	0.970
##	3	76	4	0.857	0.0382	0.785	0.935
##	4	72	4	0.810	0.0428	0.730	0.898
##	5	68	4	0.762	0.0465	0.676	0.859
##	6	64	4	0.714	0.0493	0.624	0.818
##	7	60	4	0.667	0.0514	0.573	0.775
##	8	55	2	0.642	0.0523	0.548	0.754
##	9	49	1	0.629	0.0529	0.534	0.742
##	10	47	2	0.603	0.0539	0.506	0.718
##	11	43	2	0.575	0.0549	0.476	0.693
##	13	36	2	0.543	0.0563	0.443	0.665
##	14	33	1	0.526	0.0570	0.426	0.651
##	19	22	1	0.502	0.0592	0.399	0.633
##	31	11	1	0.457	0.0692	0.339	0.615
##	39	6	1	0.380	0.0903	0.239	0.606
##	42	5	1	0.304	0.0992	0.161	0.577

```
plot(treatmentgroups, xlab="Time in Days till Excision \n Figure 3.1",
ylab="Probability of Needing Excision",
main="Treatment Survival Function Comparison",
col=c("skyblue","purple"))
legend("topright",legend=c("Control Group, Routine Bath","Treatment Group, Chemical Bath"), col=c("skyb
```

Treatment Survival Function Comparison

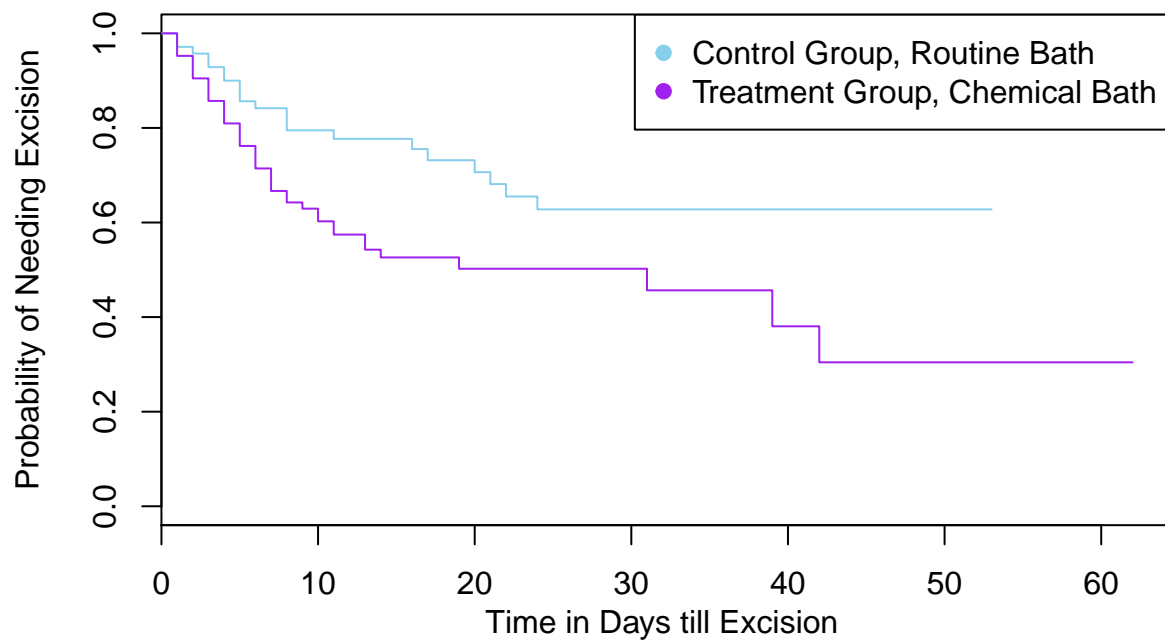


Figure 3.1

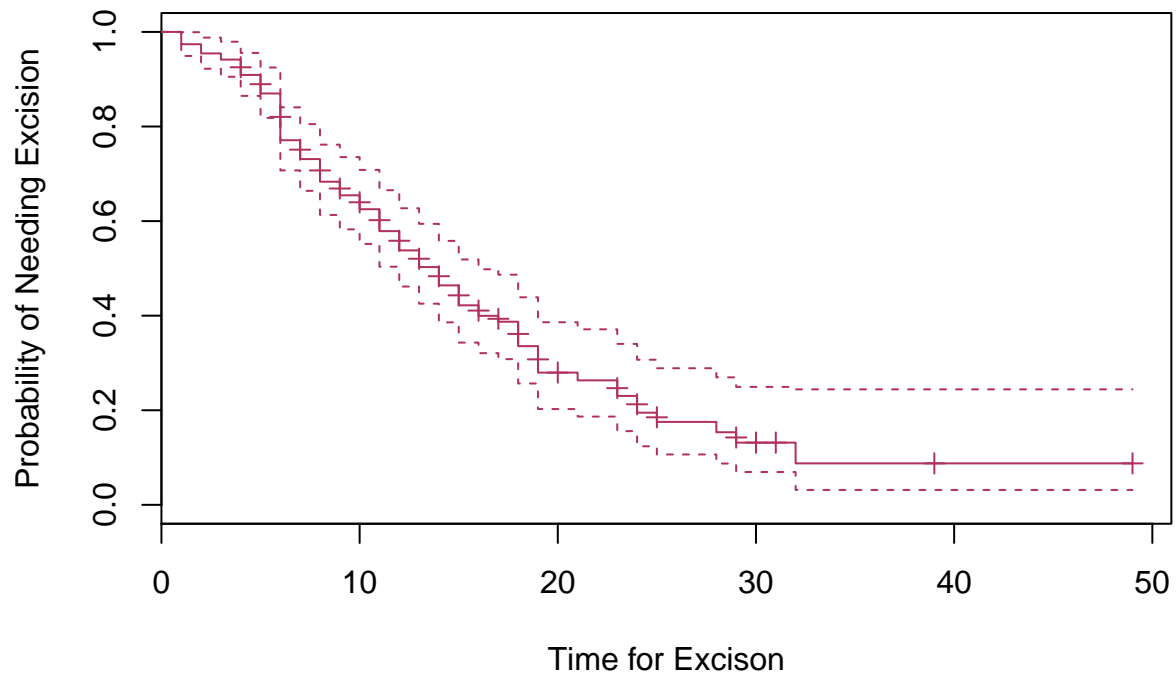
```
# end of treatment graph
```

```
# for excision
```

```
#time 1
```

```
excision.km <-survfit(Surv(burn$T1, burn$D1)~1)
```

```
plot(excision.km, xlab= "Time for Excision", ylab="Probability of Needing Excision", conf.int=TRUE,
      mark.time=TRUE, col = "maroon")
```



```
#excision km gender
```

```
excision.gender <- survfit(Surv(burn$T1, burn$D1)~Z2, data=burn)
summary(excision.gender)
```

```
## Call: survfit(formula = Surv(burn$T1, burn$D1) ~ Z2, data = burn)
```

```
##
```

```
## Z2=0
```

##	time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
##	1	120	2	0.9833	0.0117	0.9607	1.000
##	2	118	2	0.9667	0.0164	0.9351	0.999
##	3	116	2	0.9500	0.0199	0.9118	0.990
##	4	114	4	0.9167	0.0252	0.8685	0.967
##	5	109	4	0.8830	0.0294	0.8273	0.943
##	6	104	10	0.7981	0.0368	0.7291	0.874
##	7	93	4	0.7638	0.0390	0.6910	0.844
##	8	86	4	0.7283	0.0411	0.6521	0.813
##	9	77	3	0.6999	0.0426	0.6212	0.789
##	10	72	4	0.6610	0.0445	0.5794	0.754
##	11	64	4	0.6197	0.0462	0.5354	0.717
##	12	57	4	0.5762	0.0478	0.4897	0.678
##	13	48	2	0.5522	0.0488	0.4645	0.657
##	14	42	2	0.5259	0.0499	0.4367	0.633
##	15	36	2	0.4967	0.0512	0.4059	0.608
##	17	29	1	0.4796	0.0522	0.3874	0.594
##	18	27	4	0.4085	0.0553	0.3134	0.533
##	19	23	4	0.3375	0.0559	0.2439	0.467
##	21	16	1	0.3164	0.0563	0.2233	0.448
##	23	15	2	0.2742	0.0561	0.1836	0.409
##	24	12	2	0.2285	0.0553	0.1422	0.367
##	25	9	1	0.2031	0.0547	0.1199	0.344
##	28	7	1	0.1741	0.0540	0.0948	0.320
##	29	6	1	0.1451	0.0522	0.0716	0.294
##	32	3	1	0.0967	0.0526	0.0333	0.281

```
##
```

```
## Z2=1
```

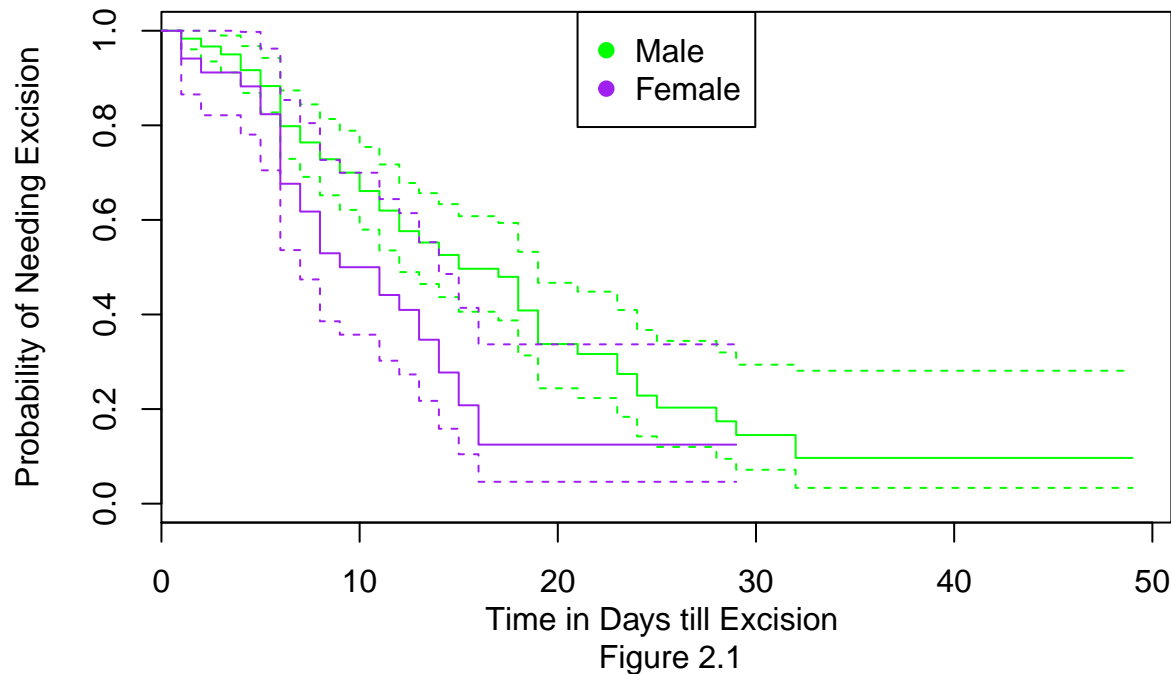
##	time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
##	1	34	2	0.941	0.0404	0.8653	1.000
##	2	32	1	0.912	0.0486	0.8212	1.000
##	4	31	1	0.882	0.0553	0.7804	0.998
##	5	30	2	0.824	0.0654	0.7049	0.962
##	6	28	5	0.676	0.0802	0.5362	0.853
##	7	23	2	0.618	0.0833	0.4741	0.805
##	8	21	3	0.529	0.0856	0.3856	0.727
##	9	18	1	0.500	0.0857	0.3573	0.700
##	11	17	2	0.441	0.0852	0.3022	0.644
##	12	14	1	0.410	0.0847	0.2732	0.614
##	13	13	2	0.347	0.0826	0.2173	0.553
##	14	10	2	0.277	0.0793	0.1583	0.486
##	15	8	2	0.208	0.0731	0.1045	0.414
##	16	5	2	0.125	0.0632	0.0462	0.337

```
plot(excision.gender, xlab="Time in Days till Excision \n Figure 2.1",
ylab="Probability of Needing Excision",
main="Excision Gender Survival Function Comparison",
```



```
col=c("green","purple"), conf.int=TRUE)
legend("top",legend=c("Male","Female"), col=c("green","purple"), pch=rep(19,2))
```

Excision Gender Survival Function Comparison



```
excision.coxph <- coxph(Surv(T1,D1)~Z2,data=burn) #log rank test for male/female difference
excision.coxph
```

```
## Call:
## coxph(formula = Surv(T1, D1) ~ Z2, data = burn)
##
##      coef exp(coef) se(coef)      z      p
## Z2 0.623      1.864    0.227  2.75 0.006
##
## Likelihood ratio test=6.89 on 1 df, p=0.009
## n= 154, number of events= 99
```

```
excision.coxph2 <- coxph(Surv(T1,D1)~.,data=burn)
excision.coxph2
```

```
## Call:
## coxph(formula = Surv(T1, D1) ~ ., data = burn)
##
##      coef exp(coef) se(coef)      z      p
## Obs -0.01148  0.98858  0.00499 -2.30 0.02138
## Z1  1.64087  5.15964  0.47505  3.45 0.00055
## Z2  0.71658  2.04741  0.24862  2.88 0.00395
## Z3  0.20694  1.22991  0.33458  0.62 0.53623
## Z4 -0.01438  0.98572  0.00848 -1.69 0.09013
## Z5 -0.14510  0.86493  0.25446 -0.57 0.56852
## Z6 -0.19930  0.81930  0.31827 -0.63 0.53118
## Z7 -0.20350  0.81587  0.33686 -0.60 0.54576
```

```
## Z8 0.38795 1.47396 0.25849 1.50 0.13339
## Z9 -0.44412 0.64139 0.27969 -1.59 0.11231
## Z10 0.21057 1.23438 0.25391 0.83 0.40693
## Z11 0.01996 1.02016 0.13862 0.14 0.88552
## T2 0.00269 1.00269 0.01178 0.23 0.81958
## D2 0.29083 1.33754 0.36764 0.79 0.42890
## T3 0.02467 1.02498 0.00996 2.48 0.01327
## D3 0.25413 1.28934 0.31890 0.80 0.42550
##
## Likelihood ratio test=45 on 16 df, p=1e-04
## n= 154, number of events= 99
```

```
Models <- step(excision.coxph2, direction = "backward")
```

```
## Start: AIC=827.97
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z7 + Z8 +
## Z9 + Z10 + Z11 + T2 + D2 + T3 + D3
##
## Df AIC
## - Z11 1 825.99
## - T2 1 826.02
## - Z5 1 826.29
## - Z7 1 826.32
## - Z6 1 826.36
## - Z3 1 826.36
## - D2 1 826.59
## - D3 1 826.59
## - Z10 1 826.65
## <none> 827.97
## - Z8 1 828.17
## - Z9 1 828.59
## - Z4 1 829.06
## - Obs 1 831.31
## - T3 1 832.04
## - Z2 1 833.75
## - Z1 1 838.06
##
## Step: AIC=825.99
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z7 + Z8 +
## Z9 + Z10 + T2 + D2 + T3 + D3
##
## Df AIC
## - T2 1 824.05
## - Z5 1 824.31
## - Z7 1 824.34
## - Z6 1 824.46
## - Z3 1 824.47
## - D3 1 824.61
## - D2 1 824.62
## - Z10 1 824.80
## <none> 825.99
## - Z8 1 826.18
## - Z9 1 826.61
## - Z4 1 827.09
## - Obs 1 829.44
```

```

## - T3      1 830.08
## - Z2      1 831.75
## - Z1      1 836.46
##
## Step: AIC=824.05
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z7 + Z8 +
##      Z9 + Z10 + D2 + T3 + D3
##
##      Df      AIC
## - Z7      1 822.36
## - Z5      1 822.37
## - Z6      1 822.48
## - Z3      1 822.57
## - Z10     1 822.90
## - D2      1 822.95
## - D3      1 823.05
## <none>      824.05
## - Z8      1 824.37
## - Z9      1 824.62
## - Z4      1 825.25
## - Obs     1 827.56
## - Z2      1 829.81
## - T3      1 832.61
## - Z1      1 834.58
##
## Step: AIC=822.36
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z8 + Z9 +
##      Z10 + D2 + T3 + D3
##
##      Df      AIC
## - Z6      1 820.83
## - Z5      1 820.86
## - Z3      1 821.00
## - D2      1 821.23
## - D3      1 821.34
## - Z10     1 821.43
## <none>      822.36
## - Z9      1 822.65
## - Z8      1 822.87
## - Z4      1 824.04
## - Obs     1 825.88
## - Z2      1 827.87
## - T3      1 830.85
## - Z1      1 832.66
##
## Step: AIC=820.83
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z8 + Z9 + Z10 +
##      D2 + T3 + D3
##
##      Df      AIC
## - Z5      1 819.13
## - Z3      1 819.54
## - D2      1 819.59
## - D3      1 819.72

```

```

## - Z10    1 820.08
## <none>    820.83
## - Z8     1 820.87
## - Z9     1 821.23
## - Z4     1 823.49
## - Obs    1 824.07
## - Z2     1 825.95
## - T3     1 830.59
## - Z1     1 830.68
##
## Step: AIC=819.13
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z8 + Z9 + Z10 + D2 +
##      T3 + D3
##
##      Df      AIC
## - Z3     1 817.84
## - D2     1 817.95
## - D3     1 818.04
## - Z10    1 818.33
## <none>    819.13
## - Z9     1 819.27
## - Z8     1 819.83
## - Obs    1 822.70
## - Z4     1 824.01
## - Z2     1 824.45
## - T3     1 828.98
## - Z1     1 829.50
##
## Step: AIC=817.84
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z4 + Z8 + Z9 + Z10 + D2 + T3 +
##      D3
##
##      Df      AIC
## - D2     1 816.70
## - Z10    1 817.02
## - D3     1 817.18
## - Z9     1 817.77
## <none>    817.84
## - Z8     1 818.16
## - Obs    1 821.49
## - Z4     1 822.21
## - Z2     1 822.85
## - T3     1 827.52
## - Z1     1 828.50
##
## Step: AIC=816.7
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z4 + Z8 + Z9 + Z10 + T3 + D3
##
##      Df      AIC
## - D3     1 815.80
## - Z10    1 816.08
## - Z9     1 816.60
## <none>    816.70
## - Z8     1 816.91

```

```

## - Obs    1 820.28
## - Z4     1 820.38
## - Z2     1 822.86
## - Z1     1 827.88
## - T3     1 828.24
##
## Step: AIC=815.8
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z4 + Z8 + Z9 + Z10 + T3
##
##          Df      AIC
## - Z10    1 815.46
## <none>    815.80
## - Z9     1 816.28
## - Z8     1 816.56
## - Z4     1 818.51
## - Obs    1 818.83
## - Z2     1 821.32
## - Z1     1 826.18
## - T3     1 827.15
##
## Step: AIC=815.46
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z4 + Z8 + Z9 + T3
##
##          Df      AIC
## <none>    815.46
## - Z8     1 815.82
## - Z9     1 816.55
## - Z4     1 817.00
## - Obs    1 818.00
## - Z2     1 821.14
## - Z1     1 825.14
## - T3     1 828.26

```

Models

```

## Call:
## coxph(formula = Surv(T1, D1) ~ Obs + Z1 + Z2 + Z4 + Z8 + Z9 +
##       T3, data = burn)
##
##           coef exp(coef) se(coef)      z      p
## Obs -0.01029   0.98977  0.00484 -2.13 0.03339
## Z1  1.55161   4.71908  0.45247  3.43 0.00061
## Z2  0.68007   1.97401  0.23501  2.89 0.00381
## Z4 -0.01183   0.98824  0.00652 -1.81 0.06962
## Z8  0.34557   1.41279  0.22407  1.54 0.12301
## Z9 -0.43102   0.64984  0.25050 -1.72 0.08531
## T3  0.02524   1.02556  0.00631  4.00 6.4e-05
##
## Likelihood ratio test=39.5 on 7 df, p=2e-06
## n= 154, number of events= 99

```

```

bestfit <- coxph(Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3, data = burn)
summary(bestfit)

```

```

## Call:
## coxph(formula = Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3, data = burn)

```

```
##
## n= 154, number of events= 99
##
##      coef exp(coef) se(coef)      z Pr(>|z|)
## Z1  0.703294  2.020398  0.217978  3.226 0.001253 **
## Z2  0.637646  1.892022  0.235471  2.708 0.006770 **
## Z4 -0.008352  0.991683  0.006213 -1.344 0.178867
## Z8  0.328013  1.388208  0.226126  1.451 0.146898
## Z9 -0.585068  0.557068  0.245171 -2.386 0.017016 *
## T3  0.023322  1.023596  0.006145  3.795 0.000147 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##      exp(coef) exp(-coef) lower .95 upper .95
## Z1      2.0204      0.4950      1.3179      3.0973
## Z2      1.8920      0.5285      1.1926      3.0016
## Z4      0.9917      1.0084      0.9797      1.0038
## Z8      1.3882      0.7204      0.8912      2.1624
## Z9      0.5571      1.7951      0.3445      0.9007
## T3      1.0236      0.9769      1.0113      1.0360
##
## Concordance= 0.674 (se = 0.035 )
## Rsquare= 0.203 (max possible= 0.996 )
## Likelihood ratio test= 34.96 on 6 df, p=4e-06
## Wald test = 35.16 on 6 df, p=4e-06
## Score (logrank) test = 35.75 on 6 df, p=3e-06
```

```
cox.zph(bestfit)
```

```
##      rho chisq      p
## Z1    -0.0785  0.5701 0.4502
## Z2     0.0128  0.0176 0.8946
## Z4     0.1184  1.4278 0.2321
## Z8     0.1964  4.3843 0.0363
## Z9    -0.1743  3.6150 0.0573
## T3    -0.0293  0.0917 0.7621
## GLOBAL      NA 11.4780 0.0747
```

```
befit <- coxph(Surv(T1, D1) ~ (Z1 + Z2 + Z4 + Z8 + Z9 + T3)^2, data = burn)
step(befit, direction = "backward")
```

```
## Start: AIC=835.91
## Surv(T1, D1) ~ (Z1 + Z2 + Z4 + Z8 + Z9 + T3)^2
##
##      Df      AIC
## - Z4:T3  1 833.91
## - Z8:T3  1 833.91
## - Z1:Z8  1 833.94
## - Z1:Z2  1 833.95
## - Z2:Z9  1 834.03
## - Z4:Z8  1 834.05
## - Z2:T3  1 834.07
## - Z1:T3  1 834.07
## - Z9:T3  1 834.32
## - Z4:Z9  1 834.36
```

```

## - Z1:Z4 1 834.39
## - Z1:Z9 1 834.56
## - Z8:Z9 1 835.05
## - Z2:Z4 1 835.67
## <none> 835.91
## - Z2:Z8 1 839.34
##
## Step: AIC=833.91
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z2 + Z1:Z4 +
## Z1:Z8 + Z1:Z9 + Z1:T3 + Z2:Z4 + Z2:Z8 + Z2:Z9 + Z2:T3 + Z4:Z8 +
## Z4:Z9 + Z8:Z9 + Z8:T3 + Z9:T3
##
## Df AIC
## - Z8:T3 1 831.91
## - Z1:Z8 1 831.95
## - Z1:Z2 1 831.95
## - Z2:Z9 1 832.03
## - Z4:Z8 1 832.06
## - Z2:T3 1 832.08
## - Z1:T3 1 832.08
## - Z9:T3 1 832.33
## - Z4:Z9 1 832.36
## - Z1:Z4 1 832.40
## - Z1:Z9 1 832.58
## - Z8:Z9 1 833.07
## - Z2:Z4 1 833.67
## <none> 833.91
## - Z2:Z8 1 837.36
##
## Step: AIC=831.91
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z2 + Z1:Z4 +
## Z1:Z8 + Z1:Z9 + Z1:T3 + Z2:Z4 + Z2:Z8 + Z2:Z9 + Z2:T3 + Z4:Z8 +
## Z4:Z9 + Z8:Z9 + Z9:T3
##
## Df AIC
## - Z1:Z8 1 829.95
## - Z1:Z2 1 829.95
## - Z2:Z9 1 830.03
## - Z4:Z8 1 830.06
## - Z2:T3 1 830.08
## - Z1:T3 1 830.09
## - Z4:Z9 1 830.37
## - Z9:T3 1 830.41
## - Z1:Z4 1 830.42
## - Z1:Z9 1 830.59
## - Z8:Z9 1 831.07
## - Z2:Z4 1 831.69
## <none> 831.91
## - Z2:Z8 1 835.42
##
## Step: AIC=829.95
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z2 + Z1:Z4 +
## Z1:Z9 + Z1:T3 + Z2:Z4 + Z2:Z8 + Z2:Z9 + Z2:T3 + Z4:Z8 + Z4:Z9 +
## Z8:Z9 + Z9:T3

```

```

##
##           Df      AIC
## - Z1:Z2  1 827.98
## - Z2:Z9  1 828.08
## - Z2:T3  1 828.10
## - Z1:T3  1 828.12
## - Z4:Z8  1 828.14
## - Z4:Z9  1 828.42
## - Z9:T3  1 828.50
## - Z1:Z4  1 828.62
## - Z1:Z9  1 828.69
## - Z8:Z9  1 829.15
## - Z2:Z4  1 829.69
## <none>    829.95
## - Z2:Z8  1 833.44
##
## Step:  AIC=827.98
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z4 + Z1:Z9 +
##           Z1:T3 + Z2:Z4 + Z2:Z8 + Z2:Z9 + Z2:T3 + Z4:Z8 + Z4:Z9 + Z8:Z9 +
##           Z9:T3
##
##           Df      AIC
## - Z2:Z9  1 826.12
## - Z2:T3  1 826.14
## - Z1:T3  1 826.16
## - Z4:Z8  1 826.20
## - Z4:Z9  1 826.48
## - Z9:T3  1 826.54
## - Z1:Z4  1 826.63
## - Z1:Z9  1 826.74
## - Z8:Z9  1 827.17
## - Z2:Z4  1 827.69
## <none>    827.98
## - Z2:Z8  1 831.52
##
## Step:  AIC=826.12
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z4 + Z1:Z9 +
##           Z1:T3 + Z2:Z4 + Z2:Z8 + Z2:T3 + Z4:Z8 + Z4:Z9 + Z8:Z9 + Z9:T3
##
##           Df      AIC
## - Z4:Z8  1 824.27
## - Z2:T3  1 824.27
## - Z1:T3  1 824.31
## - Z9:T3  1 824.61
## - Z4:Z9  1 824.64
## - Z1:Z4  1 824.73
## - Z1:Z9  1 824.97
## - Z8:Z9  1 825.25
## - Z2:Z4  1 825.80
## <none>    826.12
## - Z2:Z8  1 829.55
##
## Step:  AIC=824.27
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z4 + Z1:Z9 +

```



```

##      Z1:T3 + Z2:Z4 + Z2:Z8 + Z2:T3 + Z4:Z9 + Z8:Z9 + Z9:T3
##
##      Df      AIC
## - Z2:T3  1 822.46
## - Z1:T3  1 822.59
## - Z9:T3  1 822.66
## - Z4:Z9  1 822.70
## - Z1:Z4  1 822.93
## - Z1:Z9  1 823.05
## - Z8:Z9  1 823.55
## - Z2:Z4  1 824.26
## <none>    824.27
## - Z2:Z8  1 827.69
##
## Step: AIC=822.46
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z4 + Z1:Z9 +
##      Z1:T3 + Z2:Z4 + Z2:Z8 + Z4:Z9 + Z8:Z9 + Z9:T3
##
##      Df      AIC
## - Z1:T3  1 820.74
## - Z4:Z9  1 820.86
## - Z9:T3  1 820.96
## - Z1:Z9  1 821.17
## - Z1:Z4  1 821.34
## - Z8:Z9  1 821.70
## - Z2:Z4  1 822.28
## <none>    822.46
## - Z2:Z8  1 825.71
##
## Step: AIC=820.74
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z4 + Z1:Z9 +
##      Z2:Z4 + Z2:Z8 + Z4:Z9 + Z8:Z9 + Z9:T3
##
##      Df      AIC
## - Z4:Z9  1 819.00
## - Z1:Z9  1 819.41
## - Z9:T3  1 819.52
## - Z8:Z9  1 819.98
## - Z1:Z4  1 820.14
## - Z2:Z4  1 820.30
## <none>    820.74
## - Z2:Z8  1 824.27
##
## Step: AIC=819
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z4 + Z1:Z9 +
##      Z2:Z4 + Z2:Z8 + Z8:Z9 + Z9:T3
##
##      Df      AIC
## - Z1:Z9  1 817.47
## - Z9:T3  1 817.97
## - Z2:Z4  1 818.35
## - Z8:Z9  1 818.61
## - Z1:Z4  1 818.70
## <none>    819.00

```

```

## - Z2:Z8 1 822.32
##
## Step: AIC=817.47
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z4 + Z2:Z4 +
##      Z2:Z8 + Z8:Z9 + Z9:T3
##
##      Df      AIC
## - Z9:T3 1 816.49
## - Z2:Z4 1 816.87
## - Z8:Z9 1 816.87
## <none>      817.47
## - Z1:Z4 1 817.69
## - Z2:Z8 1 820.61
##
## Step: AIC=816.49
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z4 + Z2:Z4 +
##      Z2:Z8 + Z8:Z9
##
##      Df      AIC
## - Z2:Z4 1 815.68
## - Z8:Z9 1 816.21
## - Z1:Z4 1 816.40
## <none>      816.49
## - Z2:Z8 1 819.24
## - T3     1 829.39
##
## Step: AIC=815.68
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z4 + Z2:Z8 +
##      Z8:Z9
##
##      Df      AIC
## - Z8:Z9 1 814.89
## <none>      815.68
## - Z1:Z4 1 815.89
## - Z2:Z8 1 819.54
## - T3     1 828.87
##
## Step: AIC=814.89
## Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 + Z1:Z4 + Z2:Z8
##
##      Df      AIC
## <none>      814.89
## - Z1:Z4 1 815.40
## - Z2:Z8 1 818.48
## - Z9     1 819.90
## - T3     1 828.08
##
## Call:
## coxph(formula = Surv(T1, D1) ~ Z1 + Z2 + Z4 + Z8 + Z9 + T3 +
##      Z1:Z4 + Z2:Z8, data = burn)
##
##      coef exp(coef) se(coef)      z      p
## Z1    1.21666   3.37589  0.38979  3.12 0.00180
## Z2    1.20824   3.34759  0.32285  3.74 0.00018

```

```

## Z4      -0.00159    0.99841    0.00819   -0.19  0.84596
## Z8       0.65456    1.92429    0.26434    2.48  0.01328
## Z9      -0.64142    0.52654    0.24889   -2.58  0.00996
## T3       0.02566    1.02600    0.00636    4.04  5.5e-05
## Z1:Z4   -0.01879    0.98139    0.01198   -1.57  0.11681
## Z2:Z8   -1.10916    0.32983    0.46911   -2.36  0.01806
##
## Likelihood ratio test=42.08  on 8 df, p=1e-06
## n= 154, number of events= 99
befit1 <- coxph(Surv(T3, D3) ~ (Z1 + Z2 + Z3 + Z6 + D1 + D2)^2, data = burn)

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,4,5,6,8,12,14,17,18 ; beta may be
## infinite.

step(befit1, direction = "backward")

## Start:  AIC=424.42
## Surv(T3, D3) ~ (Z1 + Z2 + Z3 + Z6 + D1 + D2)^2

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,4,5,6,7,11,13,16,17 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,5,6,11,13,16,17 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,5,6,8,11,13,16,17 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,5,6,11,13,16,17 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,4,5,6,11,13,16,17 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,4,6,8,13,15,17 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,4,5,6,8,12,13,16,17 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,4,5,6,8,12,15,16,17 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,4,5,6,8,12,14,16,17 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,5,6,8,12,14,16,17 ; beta may be
## infinite.

```

```

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,17 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,5,8,12,14,17 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,4,5,6,8,12,14,17,18 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,4,5,6,8,12,14,17,18 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,5,6,12,14,17,18 ; beta may be
## infinite.

##           Df      AIC
## - Z3:D1  1 422.42
## - Z3:Z6  1 422.42
## - Z1:Z3  1 422.42
## - Z2:Z6  1 422.49
## - Z6:D2  1 422.51
## - Z1:Z2  1 422.56
## - Z2:Z3  1 422.90
## - D1:D2  1 423.24
## - Z3:D2  1 423.27
## - Z6:D1  1 423.38
## - Z1:Z6  1 423.72
## - Z1:D2  1 424.25
## <none>    424.42
## - Z2:D1  1 426.44
## - Z2:D2  1 427.64
## - Z1:D1  1 430.00

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,17 ; beta may be infinite.

##
## Step:  AIC=422.42
## Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 + Z1:Z2 + Z1:Z3 +
##           Z1:Z6 + Z1:D1 + Z1:D2 + Z2:Z3 + Z2:Z6 + Z2:D1 + Z2:D2 + Z3:Z6 +
##           Z3:D2 + Z6:D1 + Z6:D2 + D1:D2

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,7,11,13,16 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,11,13,16 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,13,16 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,13,16 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :

```

```

## Loglik converged before variable 1,2,3,6,8,11,13,16 ; beta may be infinite.
## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,4,6,8,13,15,16 ; beta may be
## infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,13,16 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,16 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,16 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,16 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,8,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,17 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,17 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,4,6,8,12,14,17 ; beta may be
## infinite.

##          Df      AIC
## - Z3:Z6  1 420.42
## - Z2:Z6  1 420.49
## - Z6:D2  1 420.51
## - Z1:Z2  1 420.56
## - Z1:Z3  1 420.57
## - Z2:Z3  1 420.90
## - D1:D2  1 421.24
## - Z6:D1  1 421.38
## - Z1:Z6  1 421.72
## - Z1:D2  1 422.25
## <none>    422.42
## - Z3:D2  1 424.29
## - Z2:D1  1 424.44
## - Z2:D2  1 425.64
## - Z1:D1  1 428.00

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,16 ; beta may be infinite.

##
## Step:  AIC=420.42
## Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 + Z1:Z2 + Z1:Z3 +
##          Z1:Z6 + Z1:D1 + Z1:D2 + Z2:Z3 + Z2:Z6 + Z2:D1 + Z2:D2 + Z3:D2 +
##          Z6:D1 + Z6:D2 + D1:D2

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,7,11,13,15 ; beta may be infinite.

```

```

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,11,13,15 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,13,15 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,13,15 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,13,15 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,13,15 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,13,15 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,15 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,15 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,8,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,16 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,16 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14,16 ; beta may be infinite.

##          Df      AIC
## - Z2:Z6   1 418.49
## - Z6:D2   1 418.51
## - Z1:Z2   1 418.56
## - Z1:Z3   1 418.57
## - D1:D2   1 419.24
## - Z6:D1   1 419.38
## - Z1:Z6   1 419.72
## - Z2:Z3   1 419.94
## - Z1:D2   1 420.25
## <none>    420.42
## - Z3:D2   1 422.29
## - Z2:D1   1 422.44
## - Z2:D2   1 423.64
## - Z1:D1   1 426.00

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,13,15 ; beta may be infinite.

##
## Step:  AIC=418.49
## Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 + Z1:Z2 + Z1:Z3 +
##           Z1:Z6 + Z1:D1 + Z1:D2 + Z2:Z3 + Z2:D1 + Z2:D2 + Z3:D2 + Z6:D1 +

```

```

##      Z6:D2 + D1:D2

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,7,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,13,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,8,12,13 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,13,15 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,13,15 ; beta may be infinite.

##      Df      AIC
## - Z6:D2  1 416.55
## - Z1:Z2  1 416.64
## - Z1:Z3  1 416.64
## - D1:D2  1 417.37
## - Z6:D1  1 417.70
## - Z1:Z6  1 417.75
## - Z2:Z3  1 418.02
## - Z1:D2  1 418.27
## <none>    418.49
## - Z3:D2  1 420.29
## - Z2:D1  1 420.64
## - Z2:D2  1 421.65
## - Z1:D1  1 424.03

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,13,15 ; beta may be infinite.

##
## Step:  AIC=416.55
## Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 + Z1:Z2 + Z1:Z3 +

```

```

##      Z1:Z6 + Z1:D1 + Z1:D2 + Z2:Z3 + Z2:D1 + Z2:D2 + Z3:D2 + Z6:D1 +
##      D1:D2

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,7,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,13,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,8,12,13 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,13,15 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 1,2,3,6,8,12,13,15 ; beta may be infinite.

##      Df      AIC
## - Z1:Z3  1 414.71
## - Z1:Z2  1 414.72
## - D1:D2  1 415.40
## - Z6:D1  1 415.70
## - Z1:Z6  1 415.86
## - Z2:Z3  1 416.02
## - Z1:D2  1 416.33
## <none>    416.55
## - Z3:D2  1 418.30
## - Z2:D1  1 418.65
## - Z2:D2  1 419.71
## - Z1:D1  1 422.25

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,11,12,14 ; beta may be infinite.

##
## Step:  AIC=414.71
## Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 + Z1:Z2 + Z1:Z6 +
##      Z1:D1 + Z1:D2 + Z2:Z3 + Z2:D1 + Z2:D2 + Z3:D2 + Z6:D1 + D1:D2

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :

```



```

## Loglik converged before variable 2,3,6,10,11,13 ; beta may be infinite.
## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,11,13 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,11,13 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,11,13 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,11,13 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,11,12,13 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,11,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,11,12,14 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,11,12,14 ; beta may be infinite.

##          Df      AIC
## - Z1:Z2   1 412.86
## - D1:D2   1 413.77
## - Z6:D1   1 413.95
## - Z1:Z6   1 414.12
## <none>    414.71
## - Z2:Z3   1 414.76
## - Z1:D2   1 414.76
## - Z2:D1   1 416.72
## - Z2:D2   1 417.83
## - Z3:D2   1 418.02
## - Z1:D1   1 420.42

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,11,13 ; beta may be infinite.

##
## Step:  AIC=412.86
## Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 + Z1:Z6 + Z1:D1 +
##          Z1:D2 + Z2:Z3 + Z2:D1 + Z2:D2 + Z3:D2 + Z6:D1 + D1:D2

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,12 ; beta may be infinite.

```

```

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,11,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,10,11 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,11,13 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,11,13 ; beta may be infinite.

##           Df      AIC
## - D1:D2  1 411.93
## - Z6:D1  1 412.10
## - Z1:Z6  1 412.31
## - Z2:Z3  1 412.82
## <none>    412.86
## - Z1:D2  1 413.41
## - Z2:D1  1 414.72
## - Z3:D2  1 416.06
## - Z2:D2  1 416.49
## - Z1:D1  1 418.58

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,11,13 ; beta may be infinite.

##
## Step:  AIC=411.93
## Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 + Z1:Z6 + Z1:D1 +
##           Z1:D2 + Z2:Z3 + Z2:D1 + Z2:D2 + Z3:D2 + Z6:D1

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,11,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,10,11 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :

```

```

## Loglik converged before variable 2,3,6,10,11,13 ; beta may be infinite.

##           Df      AIC
## - Z6:D1  1 410.64
## - Z1:Z6  1 411.36
## <none>    411.93
## - Z2:Z3  1 412.11
## - Z1:D2  1 412.16
## - Z3:D2  1 415.45
## - Z2:D1  1 415.82
## - Z1:D1  1 417.44
## - Z2:D2  1 417.61

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,11,13 ; beta may be infinite.

##
## Step:  AIC=410.64
## Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 + Z1:Z6 + Z1:D1 +
##           Z1:D2 + Z2:Z3 + Z2:D1 + Z2:D2 + Z3:D2

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,10,12 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,10,11 ; beta may be infinite.

##           Df      AIC
## - Z1:Z6  1 409.68
## <none>    410.64
## - Z1:D2  1 410.90
## - Z2:Z3  1 410.93
## - Z2:D1  1 413.99
## - Z3:D2  1 414.25
## - Z2:D2  1 416.23
## - Z1:D1  1 416.80

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,12 ; beta may be infinite.

##
## Step:  AIC=409.68
## Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 + Z1:D1 + Z1:D2 +
##           Z2:Z3 + Z2:D1 + Z2:D2 + Z3:D2

```

```

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,5,8,9,11 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,8,9,11 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,8,9,11 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,11 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,11 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,9,10,11 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,9,10 ; beta may be infinite.

##          Df      AIC
## - Z1:D2    1 409.37
## <none>      409.68
## - Z2:Z3    1 410.26
## - Z3:D2    1 413.42
## - Z2:D1    1 413.59
## - Z2:D2    1 414.59
## - Z6       1 416.54
## - Z1:D1    1 417.22

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,8,9,11 ; beta may be infinite.

##
## Step:  AIC=409.37
## Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 + Z1:D1 + Z2:Z3 +
##          Z2:D1 + Z2:D2 + Z3:D2

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,5,7,8,10 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,7,8,10 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,8,10 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,8,10 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,8,9,10 ; beta may be infinite.

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,8,9 ; beta may be infinite.

##          Df      AIC
## <none>      409.37
## - Z2:Z3    1 409.84

```

```
## - Z2:D1 1 411.97
## - Z3:D2 1 413.06
## - Z2:D2 1 413.16
## - Z6 1 414.93
## - Z1:D1 1 415.46

## Call:
## coxph(formula = Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 +
##       Z1:D1 + Z2:Z3 + Z2:D1 + Z2:D2 + Z3:D2, data = burn)
##
##               coef exp(coef) se(coef)      z      p
## Z1      5.39e-01  1.71e+00  4.65e-01  1.16 0.2464
## Z2     -3.84e+01  2.16e-17  8.94e+03  0.00 0.9966
## Z3      1.91e+01  1.99e+08  4.94e+03  0.00 0.9969
## Z6      1.05e+00  2.85e+00  3.65e-01  2.87 0.0041
## D1      3.04e-02  1.03e+00  4.46e-01  0.07 0.9456
## D2      1.83e+01  8.66e+07  4.94e+03  0.00 0.9970
## Z1:D1 -1.77e+00  1.70e-01  6.19e-01 -2.86 0.0042
## Z2:Z3  1.84e+01  9.73e+07  5.85e+03  0.00 0.9975
## Z2:D1  1.88e+01  1.46e+08  6.77e+03  0.00 0.9978
## Z2:D2  2.03e+00  7.60e+00  8.61e-01  2.36 0.0185
## Z3:D2 -1.99e+01  2.20e-09  4.94e+03  0.00 0.9968
##
## Likelihood ratio test=51.21 on 11 df, p=4e-07
## n= 154, number of events= 48

befit2<-coxph(Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 +
  Z1:D1 + Z2:Z3 + Z2:D1 + Z2:D2 + Z3:D2, data = burn)

## Warning in fitter(X, Y, strats, offset, init, control, weights = weights, :
## Loglik converged before variable 2,3,6,8,9,11 ; beta may be infinite.

befit2$coefficients

##           Z1           Z2           Z3           Z6           D1           D2
## 0.5387420 -38.3742652 19.1081661 1.0458371 0.0304163 18.2767177
##      Z1:D1      Z2:Z3      Z2:D1      Z2:D2      Z3:D2
## -1.7732200 18.3935373 18.7978928 2.0286188 -19.9353643

summary(befit2)

## Call:
## coxph(formula = Surv(T3, D3) ~ Z1 + Z2 + Z3 + Z6 + D1 + D2 +
##       Z1:D1 + Z2:Z3 + Z2:D1 + Z2:D2 + Z3:D2, data = burn)
##
## n= 154, number of events= 48
##
##               coef exp(coef) se(coef)      z Pr(>|z|)
## Z1      5.387e-01  1.714e+00  4.648e-01  1.159 0.24641
## Z2     -3.837e+01  2.159e-17  8.944e+03 -0.004 0.99658
## Z3      1.911e+01  1.989e+08  4.939e+03  0.004 0.99691
## Z6      1.046e+00  2.846e+00  3.648e-01  2.867 0.00415 **
## D1      3.042e-02  1.031e+00  4.460e-01  0.068 0.94563
## D2      1.828e+01  8.659e+07  4.939e+03  0.004 0.99705
## Z1:D1 -1.773e+00  1.698e-01  6.189e-01 -2.865 0.00417 **
## Z2:Z3  1.839e+01  9.732e+07  5.850e+03  0.003 0.99749
## Z2:D1  1.880e+01  1.458e+08  6.766e+03  0.003 0.99778
```

```
## Z2:D2 2.029e+00 7.604e+00 8.613e-01 2.355 0.01851 *
## Z3:D2 -1.994e+01 2.199e-09 4.939e+03 -0.004 0.99678
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##      exp(coef) exp(-coef) lower .95 upper .95
## Z1    1.714e+00 5.835e-01  0.68919   4.2619
## Z2    2.159e-17 4.632e+16  0.00000      Inf
## Z3    1.989e+08 5.028e-09  0.00000      Inf
## Z6    2.846e+00 3.514e-01  1.39210   5.8174
## D1    1.031e+00 9.700e-01  0.43009   2.4709
## D2    8.659e+07 1.155e-08  0.00000      Inf
## Z1:D1 1.698e-01 5.890e+00  0.05047   0.5711
## Z2:Z3 9.732e+07 1.028e-08  0.00000      Inf
## Z2:D1 1.458e+08 6.858e-09  0.00000      Inf
## Z2:D2 7.604e+00 1.315e-01  1.40565  41.1299
## Z3:D2 2.199e-09 4.548e+08  0.00000      Inf
##
## Concordance= 0.794 (se = 0.046 )
## Rsquare= 0.283 (max possible= 0.942 )
## Likelihood ratio test= 51.21 on 11 df, p=4e-07
## Wald test              = 30.63 on 11 df, p=0.001
## Score (logrank) test = 43.78 on 11 df, p=8e-06
```

```
cox.zph(befit2, global = FALSE)
```

```
##      rho    chisq    p
## Z1    0.0482 1.11e-01 0.739
## Z2   -0.0265 9.32e-10 1.000
## Z3    0.0017 1.39e-13 1.000
## Z6   -0.1435 1.02e+00 0.313
## D1    0.0766 2.87e-01 0.592
## D2    0.1795 6.20e-08 1.000
## Z1:D1 -0.0356 6.07e-02 0.805
## Z2:Z3  0.1661 5.29e-08 1.000
## Z2:D1 -0.1067 3.71e-09 1.000
## Z2:D2 -0.1773 1.45e+00 0.229
## Z3:D2 -0.0878 1.88e-08 1.000
```

```
cox.zph(befit1, global = FALSE)
```

```
##      rho    chisq    p
## Z1    0.17745 6.86e-09 0.9999
## Z2    0.07914 1.15e-08 0.9999
## Z3    0.17308 3.09e-08 0.9999
## Z6   -0.07479 5.17e-09 0.9999
## D1    0.13576 1.26e-08 0.9999
## D2    0.17753 5.99e-08 0.9998
## Z1:Z2 -0.02916 3.06e-02 0.8611
## Z1:Z3 -0.25971 1.12e-08 0.9999
## Z1:Z6  0.25337 3.92e+00 0.0478
## Z1:D1 -0.03600 6.76e-02 0.7948
## Z1:D2 -0.19842 1.89e+00 0.1697
## Z2:Z3 -0.01539 2.59e-10 1.0000
## Z2:Z6  0.09868 5.07e-01 0.4767
```

```
## Z2:D1 -0.05642 3.54e-09 1.0000
## Z2:D2 -0.22746 2.23e+00 0.1354
## Z3:Z6 0.05179 9.21e-10 1.0000
## Z3:D1 -0.11950 9.85e-09 0.9999
## Z3:D2 0.00289 1.05e-11 1.0000
## Z6:D1 -0.07200 2.83e-01 0.5950
## Z6:D2 -0.17265 1.85e+00 0.1735
## D1:D2 0.03688 6.17e-02 0.8038
```

```
anova(excision.coxph2)
```

```
## Analysis of Deviance Table
## Cox model: response is Surv(T1, D1)
## Terms added sequentially (first to last)
##
##      loglik  Chisq Df Pr(>|Chi|)
## NULL -420.48
## Obs -419.37 2.2283 1 0.135504
## Z1 -415.11 8.5187 1 0.003515 **
## Z2 -410.74 8.7463 1 0.003102 **
## Z3 -410.73 0.0101 1 0.920131
## Z4 -409.96 1.5447 1 0.213915
## Z5 -409.72 0.4729 1 0.491660
## Z6 -409.25 0.9342 1 0.333765
## Z7 -409.15 0.2074 1 0.648804
## Z8 -407.89 2.5277 1 0.111860
## Z9 -406.45 2.8731 1 0.090072 .
## Z10 -405.30 2.3020 1 0.129209
## Z11 -405.17 0.2540 1 0.614299
## T2 -405.16 0.0317 1 0.858721
## D2 -401.34 7.6355 1 0.005723 **
## T3 -398.30 6.0840 1 0.013641 *
## D3 -397.98 0.6276 1 0.428244
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
step(excision.coxph2, direction = "backward")
```

```
## Start: AIC=827.97
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z7 + Z8 +
##      Z9 + Z10 + Z11 + T2 + D2 + T3 + D3
##
##      Df      AIC
## - Z11 1 825.99
## - T2 1 826.02
## - Z5 1 826.29
## - Z7 1 826.32
## - Z6 1 826.36
## - Z3 1 826.36
## - D2 1 826.59
## - D3 1 826.59
## - Z10 1 826.65
## <none> 827.97
## - Z8 1 828.17
## - Z9 1 828.59
```

```

## - Z4      1 829.06
## - Obs     1 831.31
## - T3      1 832.04
## - Z2      1 833.75
## - Z1      1 838.06
##
## Step: AIC=825.99
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z7 + Z8 +
##      Z9 + Z10 + T2 + D2 + T3 + D3
##
##      Df      AIC
## - T2      1 824.05
## - Z5      1 824.31
## - Z7      1 824.34
## - Z6      1 824.46
## - Z3      1 824.47
## - D3      1 824.61
## - D2      1 824.62
## - Z10     1 824.80
## <none>    825.99
## - Z8      1 826.18
## - Z9      1 826.61
## - Z4      1 827.09
## - Obs     1 829.44
## - T3      1 830.08
## - Z2      1 831.75
## - Z1      1 836.46
##
## Step: AIC=824.05
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z7 + Z8 +
##      Z9 + Z10 + D2 + T3 + D3
##
##      Df      AIC
## - Z7      1 822.36
## - Z5      1 822.37
## - Z6      1 822.48
## - Z3      1 822.57
## - Z10     1 822.90
## - D2      1 822.95
## - D3      1 823.05
## <none>    824.05
## - Z8      1 824.37
## - Z9      1 824.62
## - Z4      1 825.25
## - Obs     1 827.56
## - Z2      1 829.81
## - T3      1 832.61
## - Z1      1 834.58
##
## Step: AIC=822.36
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z8 + Z9 +
##      Z10 + D2 + T3 + D3
##
##      Df      AIC

```



```

## - Z6      1 820.83
## - Z5      1 820.86
## - Z3      1 821.00
## - D2      1 821.23
## - D3      1 821.34
## - Z10     1 821.43
## <none>    822.36
## - Z9      1 822.65
## - Z8      1 822.87
## - Z4      1 824.04
## - Obs     1 825.88
## - Z2      1 827.87
## - T3      1 830.85
## - Z1      1 832.66
##
## Step: AIC=820.83
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z8 + Z9 + Z10 +
##      D2 + T3 + D3
##
##      Df      AIC
## - Z5      1 819.13
## - Z3      1 819.54
## - D2      1 819.59
## - D3      1 819.72
## - Z10     1 820.08
## <none>    820.83
## - Z8      1 820.87
## - Z9      1 821.23
## - Z4      1 823.49
## - Obs     1 824.07
## - Z2      1 825.95
## - T3      1 830.59
## - Z1      1 830.68
##
## Step: AIC=819.13
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z8 + Z9 + Z10 + D2 +
##      T3 + D3
##
##      Df      AIC
## - Z3      1 817.84
## - D2      1 817.95
## - D3      1 818.04
## - Z10     1 818.33
## <none>    819.13
## - Z9      1 819.27
## - Z8      1 819.83
## - Obs     1 822.70
## - Z4      1 824.01
## - Z2      1 824.45
## - T3      1 828.98
## - Z1      1 829.50
##
## Step: AIC=817.84
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z4 + Z8 + Z9 + Z10 + D2 + T3 +

```

```

##      D3
##
##      Df      AIC
## - D2      1 816.70
## - Z10      1 817.02
## - D3      1 817.18
## - Z9      1 817.77
## <none>      817.84
## - Z8      1 818.16
## - Obs      1 821.49
## - Z4      1 822.21
## - Z2      1 822.85
## - T3      1 827.52
## - Z1      1 828.50
##
## Step: AIC=816.7
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z4 + Z8 + Z9 + Z10 + T3 + D3
##
##      Df      AIC
## - D3      1 815.80
## - Z10      1 816.08
## - Z9      1 816.60
## <none>      816.70
## - Z8      1 816.91
## - Obs      1 820.28
## - Z4      1 820.38
## - Z2      1 822.86
## - Z1      1 827.88
## - T3      1 828.24
##
## Step: AIC=815.8
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z4 + Z8 + Z9 + Z10 + T3
##
##      Df      AIC
## - Z10      1 815.46
## <none>      815.80
## - Z9      1 816.28
## - Z8      1 816.56
## - Z4      1 818.51
## - Obs      1 818.83
## - Z2      1 821.32
## - Z1      1 826.18
## - T3      1 827.15
##
## Step: AIC=815.46
## Surv(T1, D1) ~ Obs + Z1 + Z2 + Z4 + Z8 + Z9 + T3
##
##      Df      AIC
## <none>      815.46
## - Z8      1 815.82
## - Z9      1 816.55
## - Z4      1 817.00
## - Obs      1 818.00
## - Z2      1 821.14

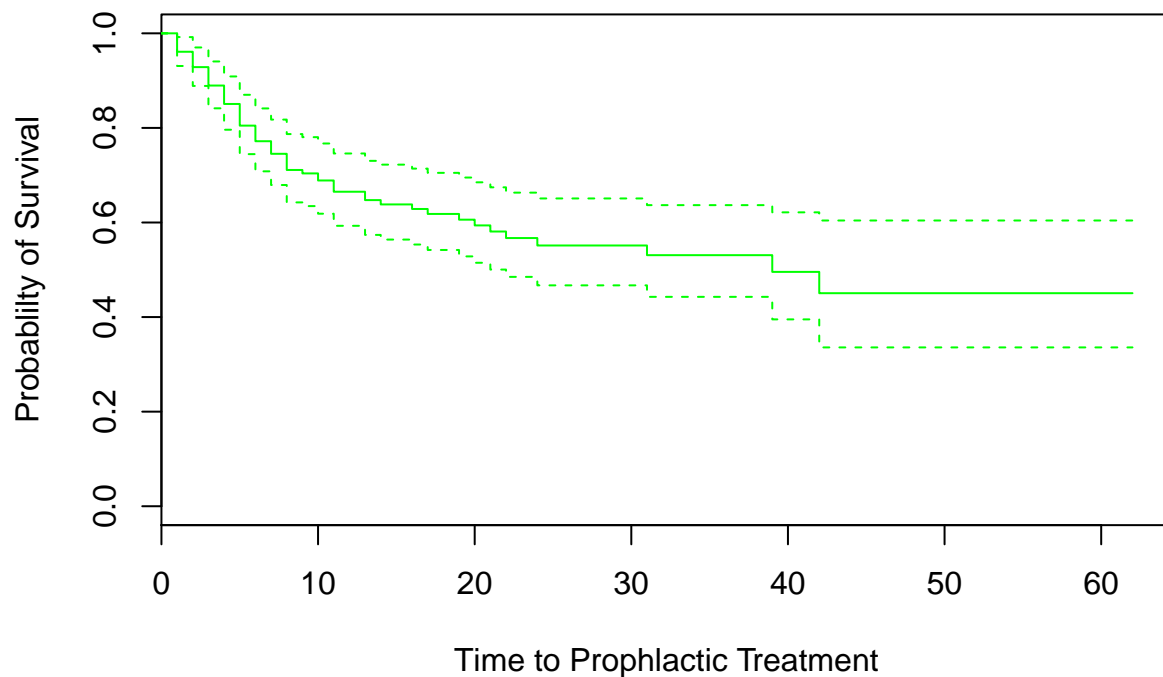
```

```
## - Z1      1 825.14
## - T3      1 828.26

## Call:
## coxph(formula = Surv(T1, D1) ~ Obs + Z1 + Z2 + Z4 + Z8 + Z9 +
##       T3, data = burn)
##
##              coef exp(coef) se(coef)      z      p
## Obs -0.01029    0.98977  0.00484 -2.13 0.03339
## Z1  1.55161    4.71908  0.45247  3.43 0.00061
## Z2  0.68007    1.97401  0.23501  2.89 0.00381
## Z4 -0.01183    0.98824  0.00652 -1.81 0.06962
## Z8  0.34557    1.41279  0.22407  1.54 0.12301
## Z9 -0.43102    0.64984  0.25050 -1.72 0.08531
## T3  0.02524    1.02556  0.00631  4.00 6.4e-05
##
## Likelihood ratio test=39.5 on 7 df, p=2e-06
## n= 154, number of events= 99
```

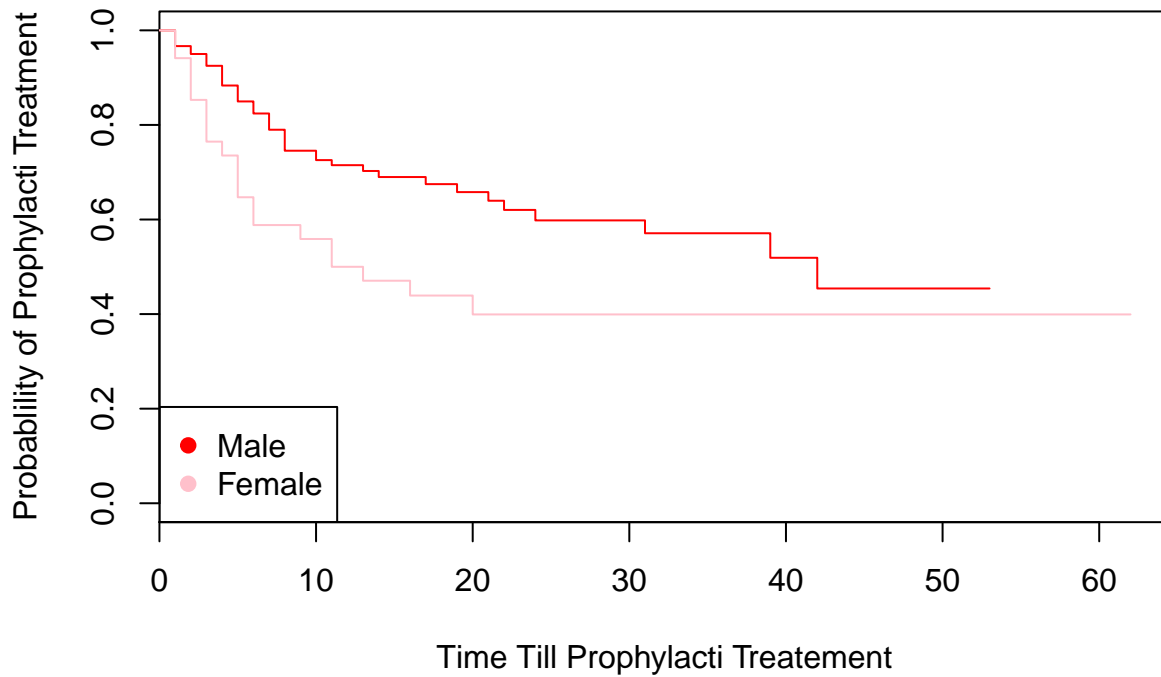
```
#time 2
```

```
Prophylacti.km <- survfit(Surv(burn$T2, burn$D2)~1)
plot(Prophylacti.km, xlab="Time to Prophylactic Treatment", ylab="Probablilty of Survival", col="green")
```



```
Prophylacti.km.gender <- survfit(Surv(T2,D2)~Z2, data=burn)
plot(Prophylacti.km.gender, xlab="Time Till Prophylacti Treatement", ylab ="Probability of Prophylacti
      main="Prophylacti Gender Comparison", col=c("red","pink"))
legend("bottomleft", legend=c("Male", "Female"), col=c("red","pink"),pch=rep(19,2))
```

Prophylacti Gender Comparison



```
Prophylacti.coxph<- coxph(Surv(T2,D2)~Z11, data=burn)
Prophylacti.coxph
```

```
## Call:
## coxph(formula = Surv(T2, D2) ~ Z11, data = burn)
##
##           coef exp(coef) se(coef)      z    p
## Z11 -0.0397    0.9611   0.1382 -0.29 0.77
##
## Likelihood ratio test=0.08 on 1 df, p=0.8
## n= 154, number of events= 63
```

```
Prophylacti.coxph2<- coxph(Surv(T2,D2)~., data=burn)
anova(Prophylacti.coxph2)
```

```
## Analysis of Deviance Table
## Cox model: response is Surv(T2, D2)
## Terms added sequentially (first to last)
##
##           loglik  Chisq Df Pr(>|Chi|)
## NULL -289.88
## Obs -287.21 5.3340 1 0.02091 *
## Z1 -286.36 1.7093 1 0.19108
## Z2 -283.32 6.0714 1 0.01374 *
## Z3 -283.09 0.4716 1 0.49227
## Z4 -279.39 7.3896 1 0.00656 **
## Z5 -279.39 0.0019 1 0.96537
## Z6 -278.94 0.9005 1 0.34264
## Z7 -278.93 0.0221 1 0.88191
## Z8 -278.93 0.0007 1 0.97851
```

```
## Z9 -278.85 0.1638 1 0.68566
## Z10 -277.23 3.2260 1 0.07248 .
## Z11 -277.12 0.2363 1 0.62686
## T1 -275.95 2.3238 1 0.12741
## D1 -275.94 0.0345 1 0.85258
## T3 -273.25 5.3705 1 0.02048 *
## D3 -272.60 1.3055 1 0.25322
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
step(Prophylacti.coxph2, direction = "backward")
```

```
## Start: AIC=577.2
## Surv(T2, D2) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z7 + Z8 +
## Z9 + Z10 + Z11 + T1 + D1 + T3 + D3
##
## Df AIC
## - Z8 1 575.21
## - Z7 1 575.22
## - Z5 1 575.23
## - Obs 1 575.29
## - Z3 1 575.56
## - D1 1 575.94
## - Z11 1 575.99
## - Z9 1 576.01
## - T1 1 576.34
## - Z6 1 576.36
## - D3 1 576.50
## - Z10 1 577.06
## <none> 577.20
## - Z1 1 577.40
## - Z4 1 577.79
## - T3 1 578.27
## - Z2 1 578.53
##
## Step: AIC=575.21
## Surv(T2, D2) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z5 + Z6 + Z7 + Z9 +
## Z10 + Z11 + T1 + D1 + T3 + D3
##
## Df AIC
## - Z5 1 573.23
## - Z7 1 573.23
## - Obs 1 573.30
## - Z3 1 573.56
## - D1 1 573.97
## - Z11 1 574.00
## - Z9 1 574.09
## - T1 1 574.36
## - Z6 1 574.50
## - D3 1 574.51
## - Z10 1 575.06
## <none> 575.21
## - Z1 1 575.44
## - Z4 1 575.84
## - T3 1 576.27
```

```

## - Z2      1 576.55
##
## Step: AIC=573.23
## Surv(T2, D2) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z6 + Z7 + Z9 + Z10 +
##      Z11 + T1 + D1 + T3 + D3
##
##      Df      AIC
## - Z7      1 571.28
## - Obs     1 571.33
## - Z3      1 571.58
## - D1      1 571.97
## - Z11     1 572.03
## - Z9      1 572.12
## - T1      1 572.38
## - D3      1 572.53
## - Z6      1 572.63
## - Z10     1 573.06
## <none>    573.23
## - Z1      1 573.47
## - Z4      1 573.94
## - T3      1 574.27
## - Z2      1 574.74
##
## Step: AIC=571.28
## Surv(T2, D2) ~ Obs + Z1 + Z2 + Z3 + Z4 + Z6 + Z9 + Z10 + Z11 +
##      T1 + D1 + T3 + D3
##
##      Df      AIC
## - Obs     1 569.38
## - Z3      1 569.64
## - D1      1 570.01
## - Z11     1 570.05
## - Z9      1 570.13
## - T1      1 570.48
## - D3      1 570.60
## - Z6      1 570.68
## - Z10     1 571.16
## <none>    571.28
## - Z1      1 571.47
## - Z4      1 571.99
## - T3      1 572.27
## - Z2      1 572.75
##
## Step: AIC=569.38
## Surv(T2, D2) ~ Z1 + Z2 + Z3 + Z4 + Z6 + Z9 + Z10 + Z11 + T1 +
##      D1 + T3 + D3
##
##      Df      AIC
## - Z3      1 567.73
## - D1      1 568.06
## - Z11     1 568.16
## - Z9      1 568.37
## - T1      1 568.70
## - D3      1 568.70

```

```

## - Z6      1 568.86
## - Z10     1 569.31
## <none>    569.38
## - Z4      1 570.18
## - T3      1 570.28
## - Z2      1 570.80
## - Z1      1 572.32
##
## Step: AIC=567.73
## Surv(T2, D2) ~ Z1 + Z2 + Z4 + Z6 + Z9 + Z10 + Z11 + T1 + D1 +
##      T3 + D3
##
##      Df      AIC
## - D1      1 566.42
## - Z11     1 566.75
## - Z9      1 566.82
## - T1      1 566.95
## - Z6      1 567.11
## - D3      1 567.18
## - Z10     1 567.53
## <none>    567.73
## - Z4      1 568.42
## - T3      1 568.97
## - Z2      1 569.12
## - Z1      1 570.56
##
## Step: AIC=566.42
## Surv(T2, D2) ~ Z1 + Z2 + Z4 + Z6 + Z9 + Z10 + Z11 + T1 + T3 +
##      D3
##
##      Df      AIC
## - T1      1 565.22
## - Z9      1 565.44
## - Z11     1 565.45
## - Z6      1 565.56
## - D3      1 566.25
## <none>    566.42
## - Z10     1 566.51
## - T3      1 566.97
## - Z4      1 567.16
## - Z2      1 567.54
## - Z1      1 569.06
##
## Step: AIC=565.22
## Surv(T2, D2) ~ Z1 + Z2 + Z4 + Z6 + Z9 + Z10 + Z11 + T3 + D3
##
##      Df      AIC
## - Z11     1 564.06
## - Z6      1 564.41
## - Z9      1 564.42
## <none>    565.22
## - D3      1 565.64
## - Z10     1 565.69
## - Z4      1 565.70

```

```

## - T3      1 565.82
## - Z2      1 566.85
## - Z1      1 568.65
##
## Step: AIC=564.06
## Surv(T2, D2) ~ Z1 + Z2 + Z4 + Z6 + Z9 + Z10 + T3 + D3
##
##          Df      AIC
## - Z9      1 563.26
## - Z6      1 563.66
## - Z10     1 563.96
## <none>     564.06
## - Z4      1 564.37
## - D3      1 564.44
## - T3      1 564.52
## - Z2      1 566.36
## - Z1      1 567.24
##
## Step: AIC=563.26
## Surv(T2, D2) ~ Z1 + Z2 + Z4 + Z6 + Z10 + T3 + D3
##
##          Df      AIC
## - Z6      1 562.52
## - Z4      1 563.05
## - T3      1 563.17
## <none>     563.26
## - Z10     1 563.29
## - D3      1 563.34
## - Z2      1 565.65
## - Z1      1 566.19
##
## Step: AIC=562.52
## Surv(T2, D2) ~ Z1 + Z2 + Z4 + Z10 + T3 + D3
##
##          Df      AIC
## - Z10     1 562.02
## - D3      1 562.43
## <none>     562.52
## - T3      1 562.59
## - Z4      1 563.96
## - Z2      1 566.09
## - Z1      1 567.97
##
## Step: AIC=562.02
## Surv(T2, D2) ~ Z1 + Z2 + Z4 + T3 + D3
##
##          Df      AIC
## - D3      1 561.78
## <none>     562.02
## - T3      1 562.92
## - Z2      1 566.01
## - Z4      1 566.07
## - Z1      1 567.37
##

```



```
## Step: AIC=561.78
## Surv(T2, D2) ~ Z1 + Z2 + Z4 + T3
##
##      Df      AIC
## <none>    561.78
## - Z4      1 564.51
## - Z2      1 565.74
## - T3      1 566.05
## - Z1      1 568.30

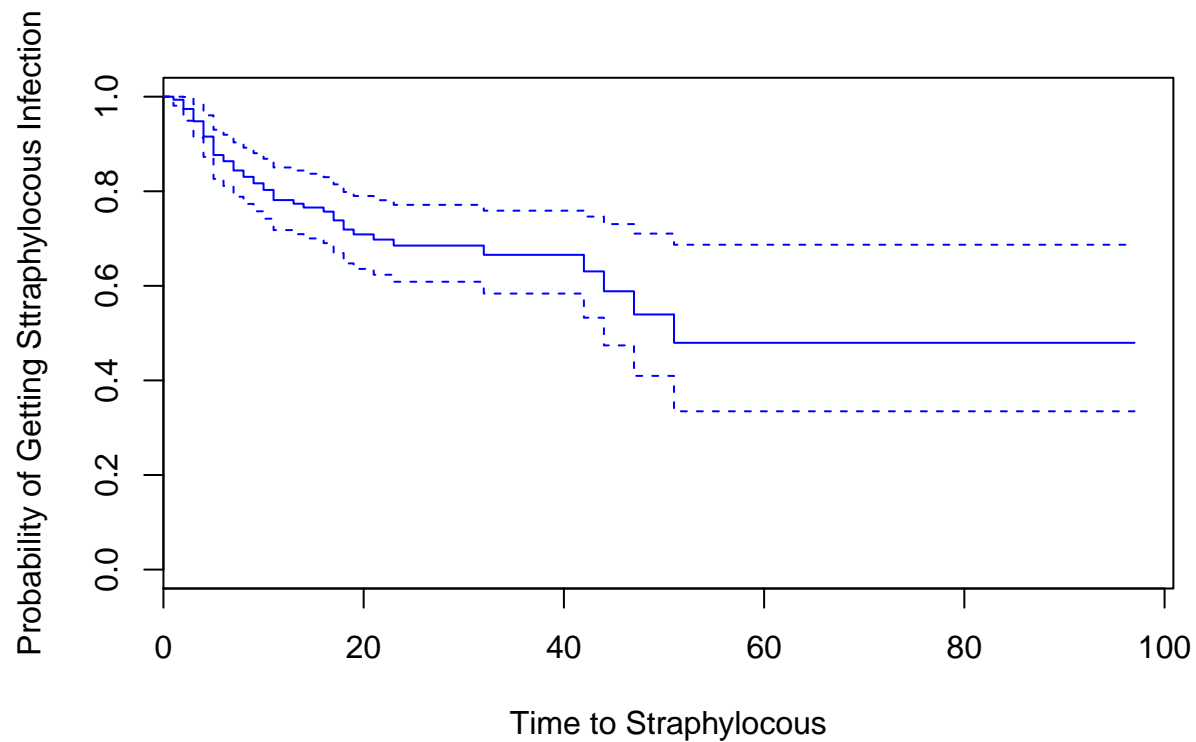
## Call:
## coxph(formula = Surv(T2, D2) ~ Z1 + Z2 + Z4 + T3, data = burn)
##
##      coef exp(coef) se(coef)      z      p
## Z1 0.78161   2.18498  0.27605  2.83 0.0046
## Z2 0.71694   2.04816  0.28144  2.55 0.0109
## Z4 0.01449   1.01460  0.00629  2.31 0.0211
## T3 0.01655   1.01669  0.00632  2.62 0.0088
##
## Likelihood ratio test=25.98 on 4 df, p=3e-05
## n= 154, number of events= 63
```

```
Prophylacti.coxph
```

```
## Call:
## coxph(formula = Surv(T2, D2) ~ Z11, data = burn)
##
##      coef exp(coef) se(coef)      z      p
## Z11 -0.0397   0.9611  0.1382 -0.29 0.77
##
## Likelihood ratio test=0.08 on 1 df, p=0.8
## n= 154, number of events= 63
```

```
#time 3
```

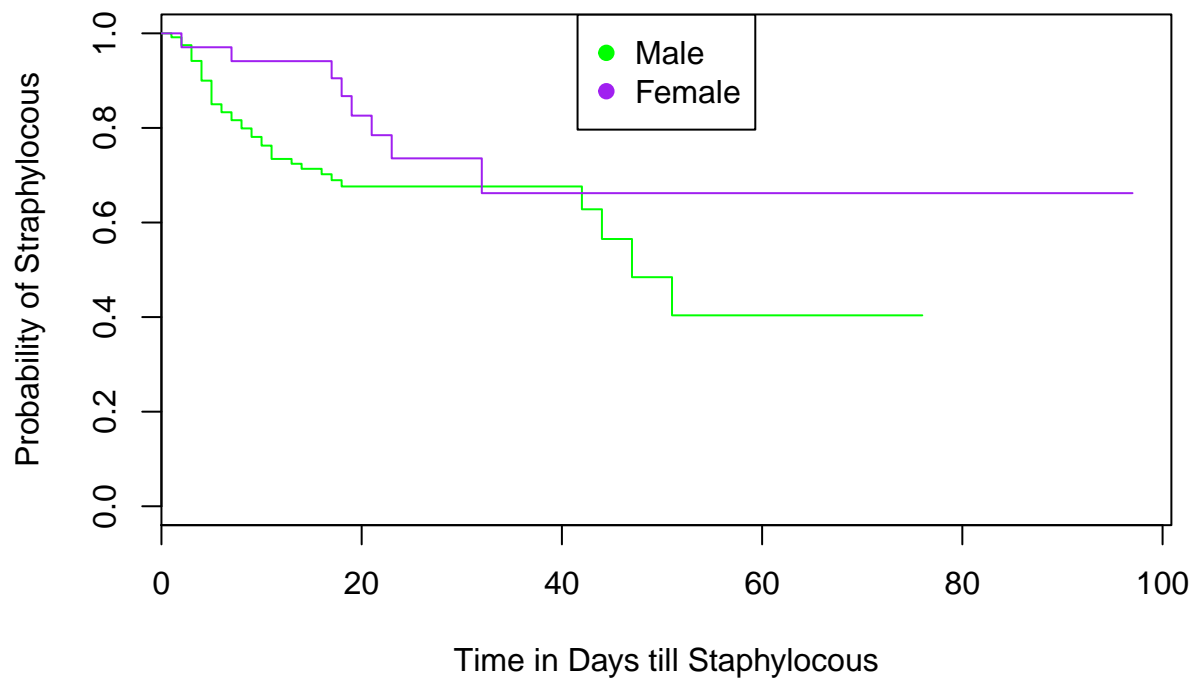
```
straphylocous.km <- survfit(Surv(burn$T3, burn$D3)~1)
plot(straphylocous.km, xlab="Time to Straphylocous", ylab = "Probability of Getting Sttraphylocous Infec")
```



```
straphylocous.km.gender <- survfit(Surv(T3, D3)~Z2, data=burn)

plot(straphylocous.km.gender, xlab="Time in Days till Staphylococcus",
     ylab="Probability of Staphylococcus",
     main="Staphylococcus Gender Survival Function Comparison",
     col=c("green","purple"))
legend("top",legend=c("Male","Female"), col=c("green","purple"), pch=rep(19,2))
```

Straphylococcus Gender Survival Function Comparison



```
#gender analysis
```

```
?burn
```

```
excision.km.ethnicity<- survfit(Surv(T1, D1)~Z3, data=burn)
```

```
summary(excision.km.ethnicity)
```

```
## Call: survfit(formula = Surv(T1, D1) ~ Z3, data = burn)
```

```
##
```

```
##           Z3=0
```

##	time	n.risk	n.event	survival	std.err	lower	95% CI	upper	95% CI
##	2	19	1	0.947	0.0512	0.8521	1.000		
##	4	18	2	0.842	0.0837	0.6931	1.000		
##	5	16	1	0.789	0.0935	0.6259	0.996		
##	6	15	2	0.684	0.1066	0.5041	0.929		
##	7	13	1	0.632	0.1107	0.4480	0.890		
##	11	12	1	0.579	0.1133	0.3946	0.850		
##	12	11	1	0.526	0.1145	0.3435	0.806		
##	15	7	1	0.451	0.1204	0.2674	0.761		
##	19	6	2	0.301	0.1182	0.1392	0.650		
##	23	2	1	0.150	0.1217	0.0308	0.734		

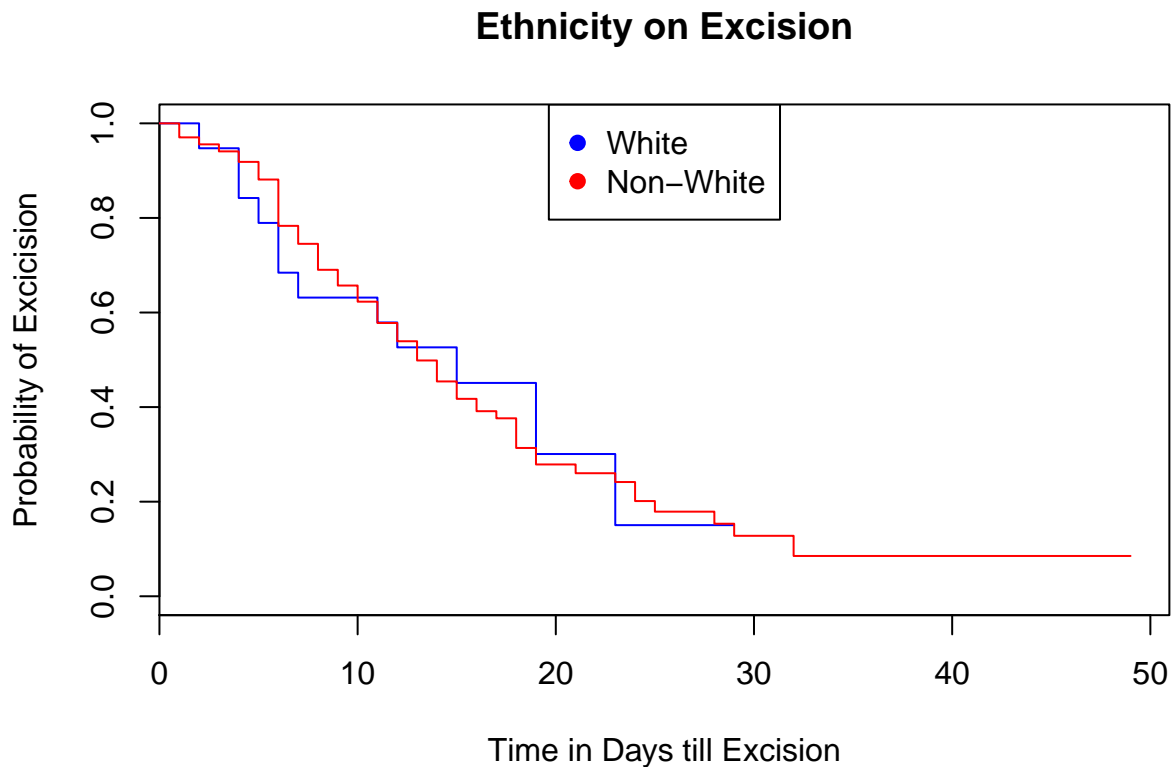
```
##
```

```
##           Z3=1
```

##	time	n.risk	n.event	survival	std.err	lower	95% CI	upper	95% CI
##	1	135	4	0.9704	0.0146	0.9422	0.999		
##	2	131	2	0.9556	0.0177	0.9214	0.991		
##	3	129	2	0.9407	0.0203	0.9017	0.981		
##	4	127	3	0.9185	0.0235	0.8735	0.966		
##	5	123	5	0.8812	0.0279	0.8282	0.938		
##	6	117	13	0.7833	0.0356	0.7164	0.856		
##	7	103	5	0.7452	0.0377	0.6748	0.823		

##	8	95	7	0.6903	0.0403	0.6158	0.774
##	9	83	4	0.6571	0.0416	0.5803	0.744
##	10	77	4	0.6229	0.0428	0.5444	0.713
##	11	69	5	0.5778	0.0442	0.4973	0.671
##	12	60	4	0.5393	0.0453	0.4575	0.636
##	13	53	4	0.4986	0.0462	0.4158	0.598
##	14	45	4	0.4543	0.0471	0.3707	0.557
##	15	37	3	0.4174	0.0478	0.3334	0.523
##	16	32	2	0.3913	0.0483	0.3073	0.498
##	17	26	1	0.3763	0.0487	0.2920	0.485
##	18	24	4	0.3136	0.0497	0.2299	0.428
##	19	18	2	0.2787	0.0499	0.1963	0.396
##	21	15	1	0.2601	0.0499	0.1786	0.379
##	23	14	1	0.2416	0.0497	0.1614	0.361
##	24	12	2	0.2013	0.0489	0.1251	0.324
##	25	9	1	0.1789	0.0483	0.1054	0.304
##	28	7	1	0.1534	0.0477	0.0834	0.282
##	29	6	1	0.1278	0.0461	0.0630	0.259
##	32	3	1	0.0852	0.0464	0.0293	0.248

```
plot(excision.km.ethnicity, xlab="Time in Days till Excision", ylab="Probability of Excicision",
     main="Ethnicity on Excision", col=c("blue", "red"))
legend("top", legend=c("White", "Non-White"), col = c("blue", "red"), pch = rep(19, 2))
```



```
log.rank.test.ethnicity <- survdiff(Surv(T1, D1)~Z3, data=burn)
log.rank.test.ethnicity
```

```
## Call:
## survdiff(formula = Surv(T1, D1) ~ Z3, data = burn)
##
```

```
##           N Observed Expected (O-E)^2/E (O-E)^2/V
## Z3=0  19         13      13.2  0.002792  0.00346
## Z3=1 135         86      85.8  0.000429  0.00346
##
## Chisq= 0  on 1 degrees of freedom, p= 1
#extremely high p-value=1, probs something wrong.
#otherwise fail to reject null, conclude survival rate the same for ethnicities.

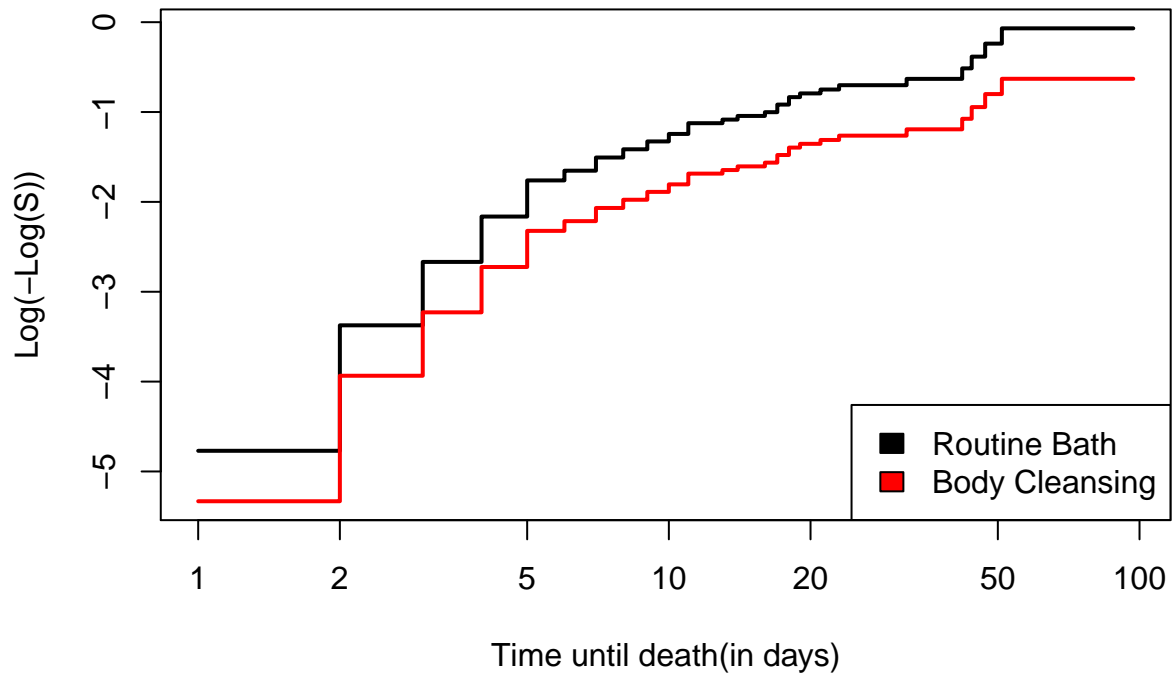
#question regarding survival rates for different burn
#null is no difference.
log.rank.test.burntype <- survdiff(Surv(T1, D1)~Z11, data=burn)
log.rank.test.burntype

## Call:
## survdiff(formula = Surv(T1, D1) ~ Z11, data = burn)
##
##           N Observed Expected (O-E)^2/E (O-E)^2/V
## Z11=1    9          7    4.23    1.818    2.02
## Z11=2   18         10   15.71    2.077    2.67
## Z11=3   11          2    6.33    2.961    3.36
## Z11=4  116        80   72.73    0.727    2.95
##
## Chisq= 8.1  on 3 degrees of freedom, p= 0.04
#p-value at .04, means no difference in type of burn

Z1cox <- coxph(Surv(T3,D3)~ Z1, data = burn)
Z2cox <- coxph(Surv(T3,D3)~ Z2 , data = burn)
Z3cox <- coxph(Surv(T3,D3)~ Z3 , data = burn)
Z6cox <- coxph(Surv(T3,D3)~ Z6 , data = burn)
D1cox <- coxph(Surv(T3,D3)~ D1 , data = burn)
D2cox <- coxph(Surv(T3,D3)~ D2 , data = burn)

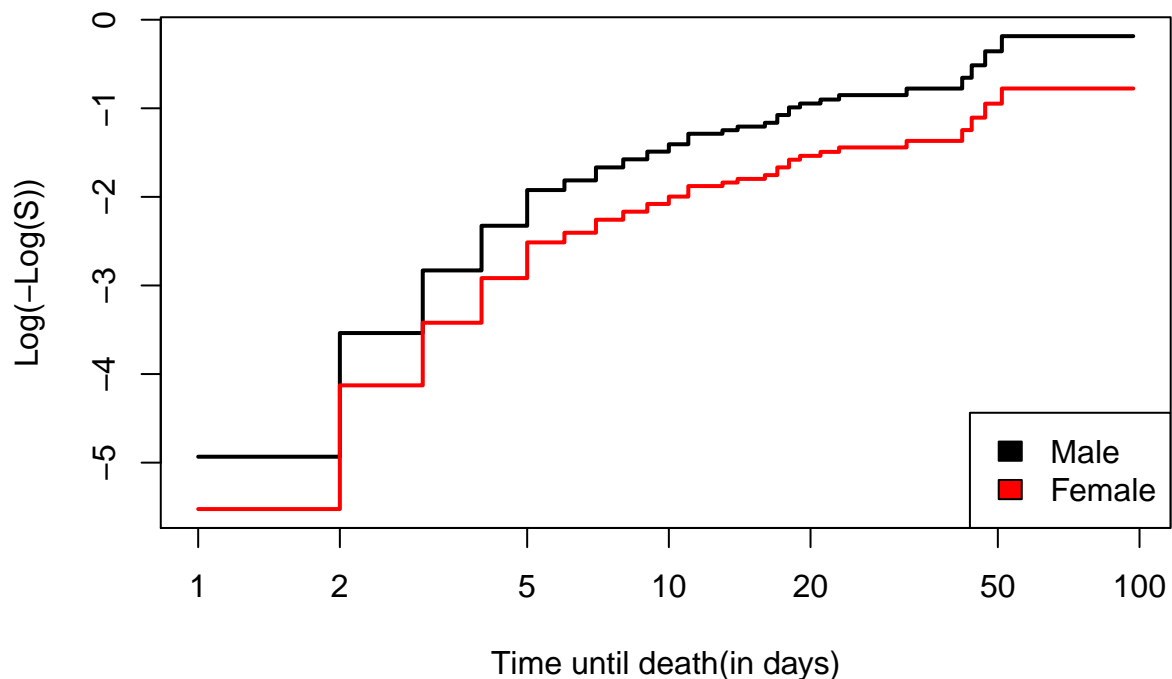
#log log Z1
plot(survfit(Z1cox,newdata=data.frame(Z1=factor(c("0", "1")))),
     fun = "cloglog", main = "Log Log Graph of Bathing Treatment" ,
     xlab="Time until death(in days)", ylab = "Log(-Log(S))", lwd = 2, col = c(1:2))
legend("bottomright", legend = c("Routine Bath", "Body Cleansing"), fill = c(1:2))
```

Log Log Graph of Bathing Treatment



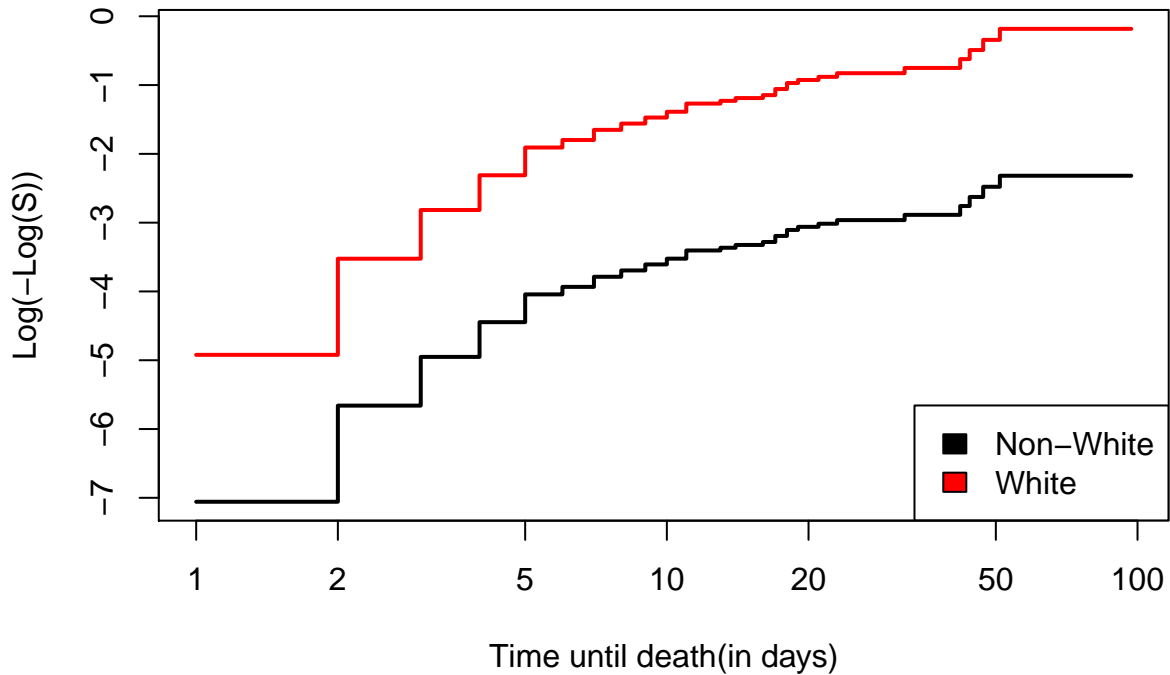
```
#log log Z2
plot(survfit(Z2cox,newdata=data.frame(Z2=factor(c("0", "1")))),
     fun = "cloglog", main = "Log Log Graph of Gender",
     xlab="Time until death(in days)", ylab = "Log(-Log(S))", lwd = 2, col = c(1:2))
legend("bottomright", legend = c("Male", "Female"), fill = c(1:2))
```

Log Log Graph of Gender



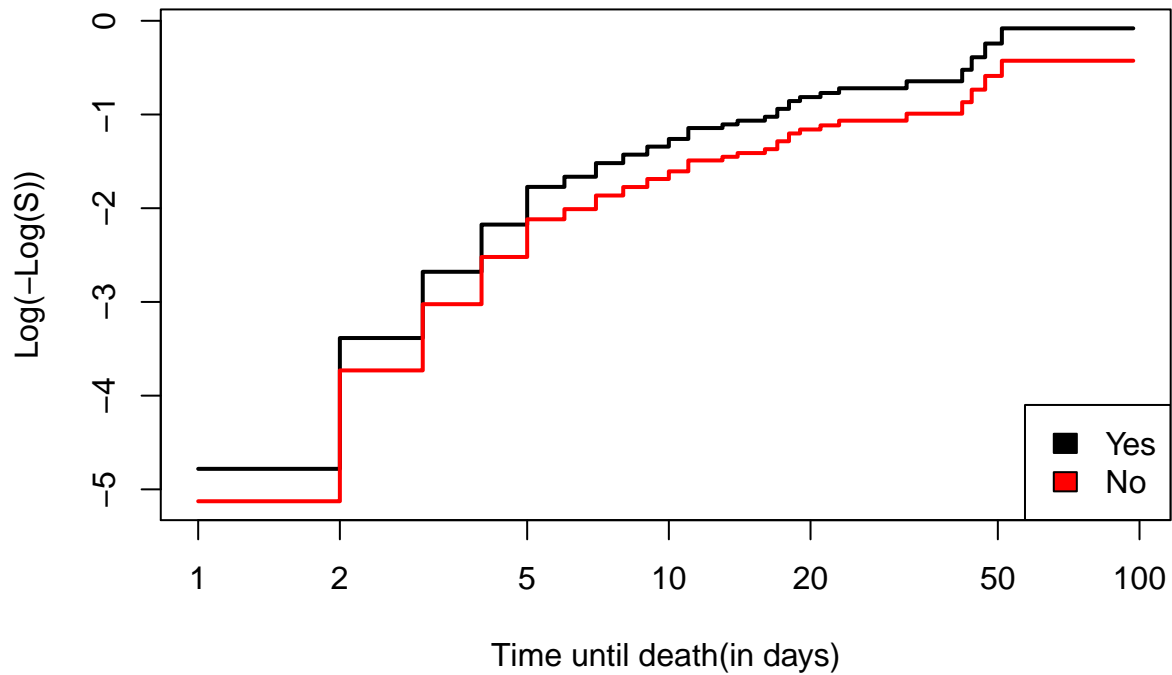
```
#log log Z3
plot(survfit(Z3cox,newdata=data.frame(Z3=factor(c("0", "1")))),
     fun = "cloglog", main = "Log Log Graph of Race" ,
     xlab="Time until death(in days)", ylab = "Log(-Log(S))", lwd = 2, col = c(1:2))
legend("bottomright", legend = c("Non-White", "White"), fill = c(1:2))
```

Log Log Graph of Race



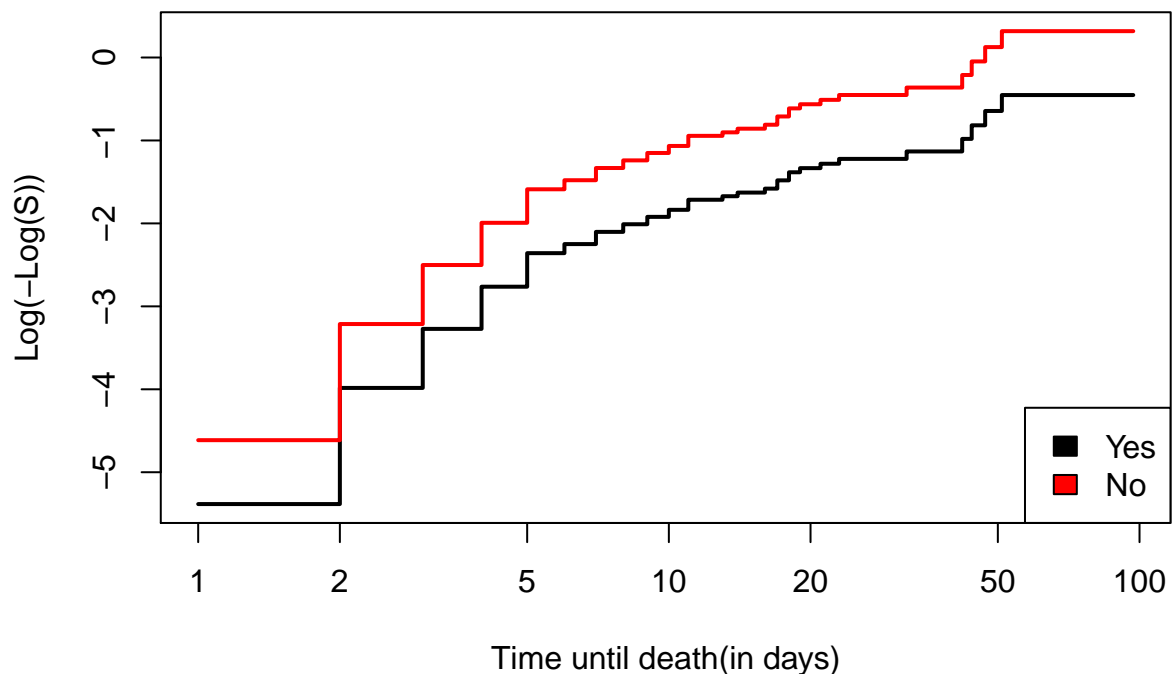
```
#log log z6
plot(survfit(Z6cox,newdata=data.frame(Z6=factor(c("1", "0")))),
     fun = "cloglog", main = "Graph of Burn Site Indicator: Buttock" ,
     xlab="Time until death(in days)", ylab = "Log(-Log(S))", lwd = 2, col = c(1:2))
legend("bottomright", legend = c("Yes", "No"), fill = c(1:2))
```

Graph of Burn Site Indicator: Buttock



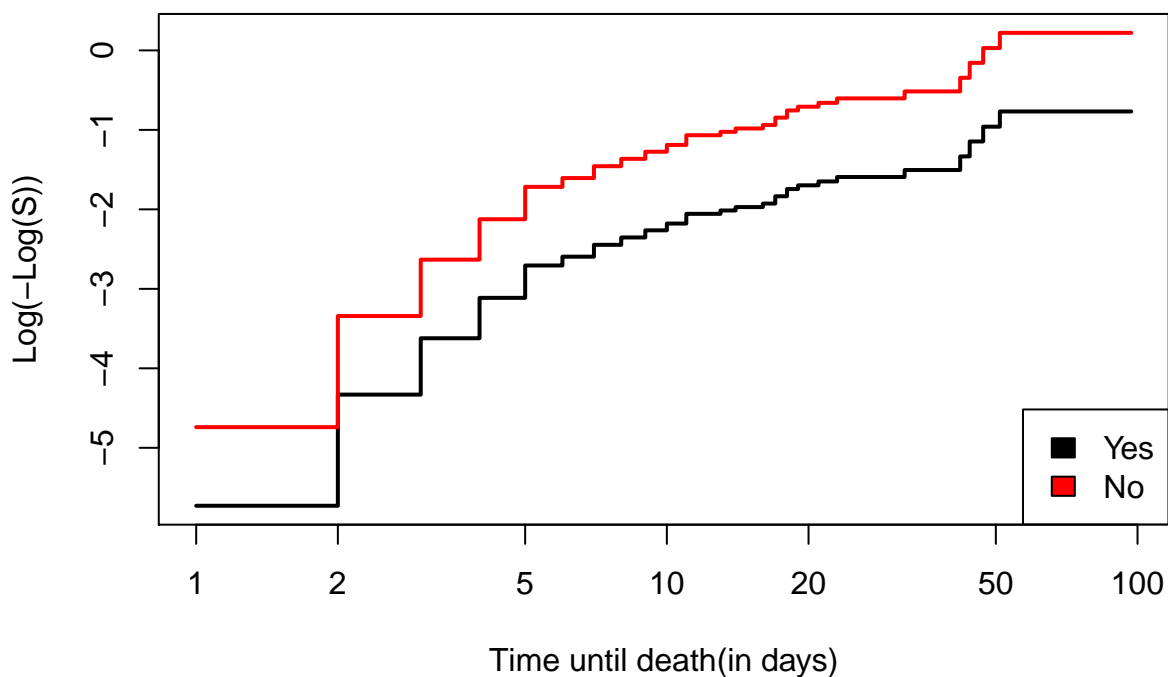
```
#log log D1
plot(survfit(D1cox,newdata=data.frame(D1=factor(c("1", "0")))),
     fun = "cloglog", main = "Log Log Graph of Excision Indicator" ,
     xlab="Time until death(in days)", ylab = "Log(-Log(S))", lwd = 2, col = c(1:2))
legend("bottomright", legend = c("Yes", "No"), fill = c(1:2))
```

Log Log Graph of Excision Indicator




```
#log log D2
plot(survfit(D2cox,newdata=data.frame(D2=factor(c("1", "0")))),
     fun = "cloglog", main = "Log Log Graph of Prophylactic Antibiotic",
     xlab="Time until death(in days)", ylab = "Log(-Log(S))", lwd = 2, col = c(1:2))
legend("bottomright", legend = c("Yes", "No"), fill = c(1:2))
```

Log Log Graph of Prophylactic Antibiotic



#extension code

Due to our burn data set have mutiple events that can occur before an infection happen. We decided
events happening prior to our D3 have any effect on the survival rate of getting an infection.

```
burn2 = survSplit(Surv(T3, D3)~.,data=burn, cut =c(20,40), episode = "TimeGroup",
id ="sub.id",end = "tstop")
head(burn2)
```

```
##   Obs  Z1  Z2  Z3  Z4  Z5  Z6  Z7  Z8  Z9  Z10  Z11  T1  D1  T2  D2  sub.id  tstart  tstop
## 1    1  0  0  0  15  0  0  1  1  0  0  2  12  0  12  0    1      0    12
## 2    2  0  0  1  20  0  0  1  0  0  0  4  9  0  9  0    2      0     9
## 3    3  0  0  1  15  0  0  0  1  1  0  2  13  0  13  0    3      0     7
## 4    4  0  0  0  20  1  0  1  0  0  0  2  11  1  29  0    4      0    20
## 5    4  0  0  0  20  1  0  1  0  0  0  2  11  1  29  0    4     20    29
## 6    5  0  0  1  70  1  1  1  1  0  0  2  28  1  31  0    5      0     4
##   D3 TimeGroup
## 1  0          1
## 2  0          1
## 3  1          1
## 4  0          1
## 5  0          2
## 6  1          1
```

```
#splitting time into episodes, and creating start and stop
```

```
plot(survfit(Surv(tstart,tstop,D3)~1,data=burn2),lwd=2,xlab="Time in Days \n Figure 4.1",ylab="S(t)",col="red",pch=1)
```

Recurrent Survival Function, Straphylococcus

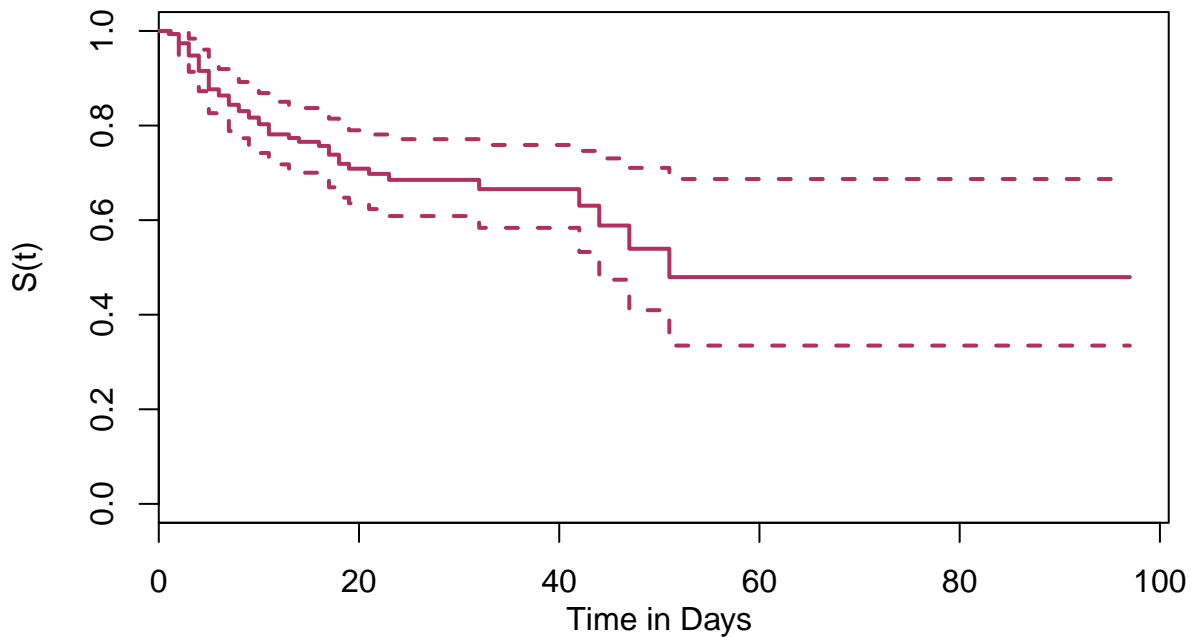
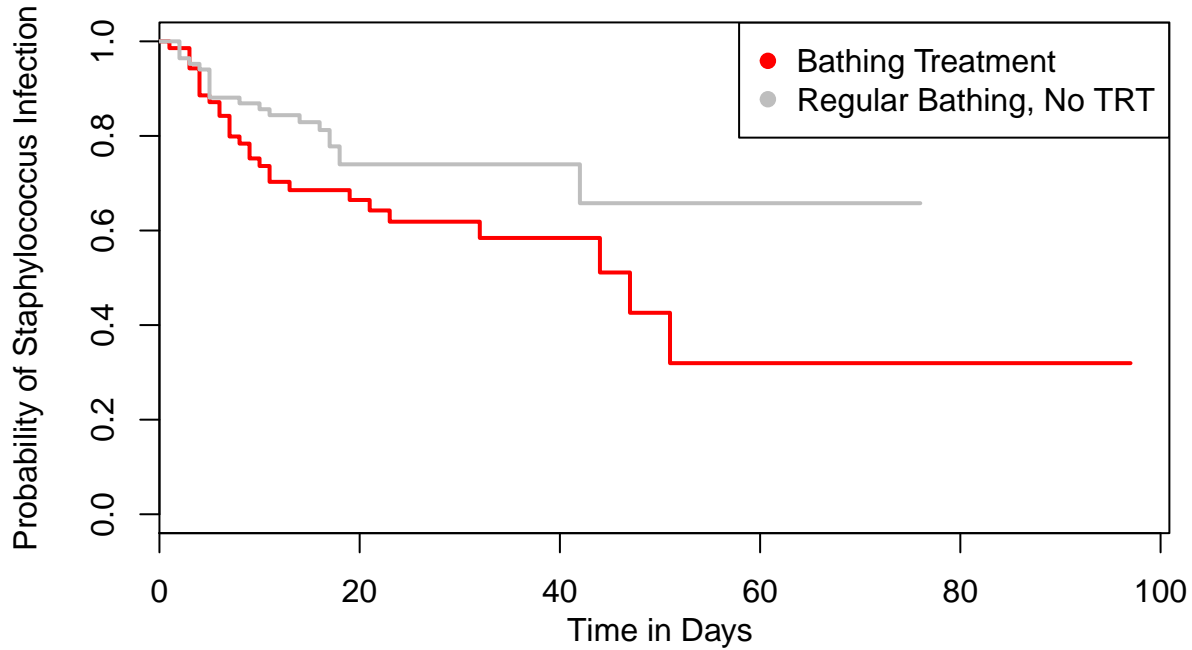


Figure 4.1

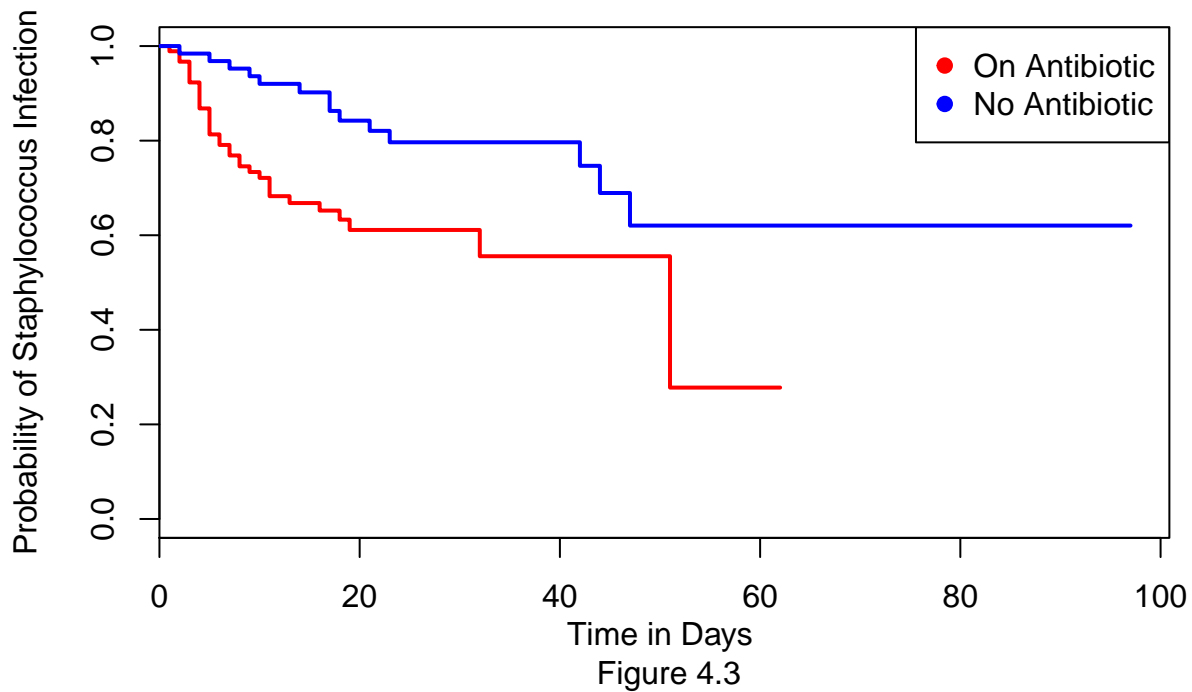
```
plot(survfit(Surv(tstart,tstop,D3)~Z1,data=burn2),lwd=2,xlab="Time in Days \n Figure 4.2",ylab="Probability of Survival",col="red",pch=1)
legend("topright", legend = c("Bathing Treatment","Regular Bathing, No TRT"), col = c("red","gray"),pch=c(1,2))
```

Recurrent Survival Function, Straphylococcous



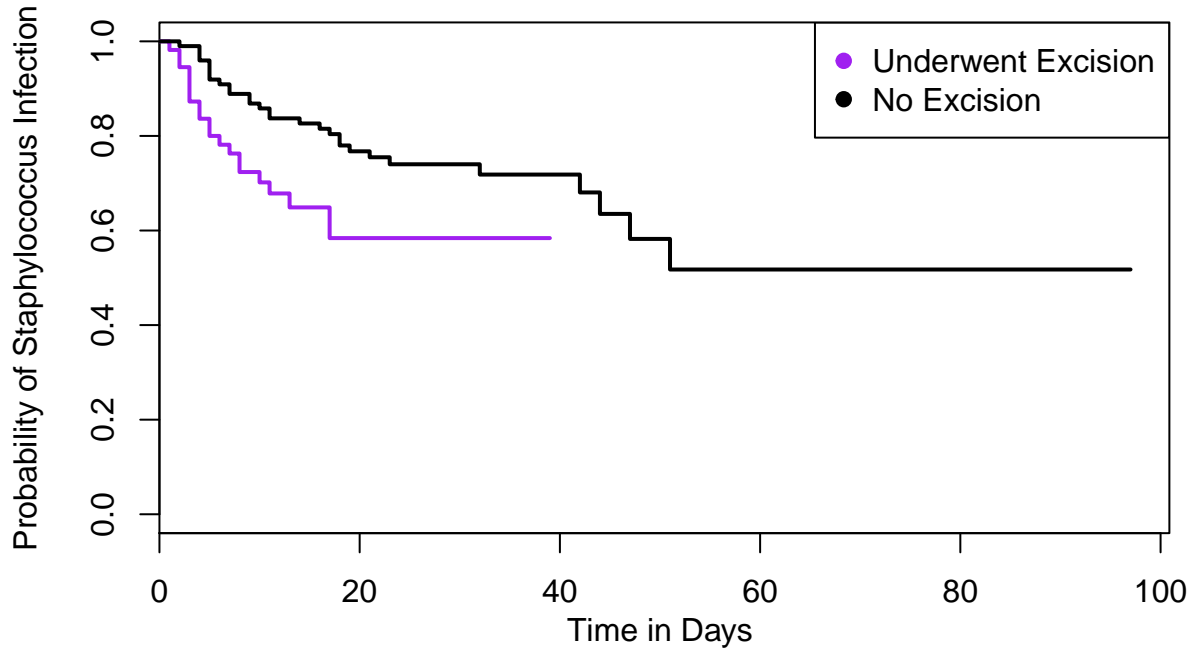
```
plot(survfit(Surv(tstart,tstop,D3)~D2,data=burn2),lwd=2,xlab="Time in Days \n Figure 4.3",ylab="Probabi
legend("topright", legend = c("On Antibiotic","No Antibiotic"), col = c("red","blue"),pch=rep(19,2))
```

Recurrent Survival Function, Straphylococous



```
plot(survfit(Surv(tstart,tstop,D3)~D1,data=burn2),lwd=2,xlab="Time in Days \n Figure 4.4",ylab="Probabi
legend("topright", legend = c("Underwent Excision","No Excision"), col = c("purple","black"),pch=rep(19
```

Recurrent Survival Function, Straphylococcus



```
rets.ft <- coxph(Surv(tstart, tstop, D3) ~ D1 + D2 + D2:(TimeGroup),
  data=burn2)
summary(rets.ft)
```

```
## Call:
## coxph(formula = Surv(tstart, tstop, D3) ~ D1 + D2 + D2:(TimeGroup),
##       data = burn2)
##
##      n= 240, number of events= 48
##
##              coef exp(coef) se(coef)      z Pr(>|z|)
## D1          -0.6198   0.5380   0.3209 -1.931  0.0534 .
## D2          -1.4850   0.2265   0.8286 -1.792  0.0731 .
## D2:TimeGroup  0.4583   1.5814   0.6093  0.752  0.4520
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##              exp(coef) exp(-coef) lower .95 upper .95
## D1              0.5380     1.8586   0.28685   1.009
## D2              0.2265     4.4148   0.04465   1.149
## D2:TimeGroup    1.5814     0.6323   0.47903   5.221
##
## Concordance= 0.669  (se = 0.043 )
## Rsquare= 0.058  (max possible= 0.839 )
## Likelihood ratio test= 14.44  on 3 df,   p=0.002
## Wald test               = 12.97  on 3 df,   p=0.005
## Score (logrank) test = 14.18  on 3 df,   p=0.003
```

```
anova(rets.ft)
```

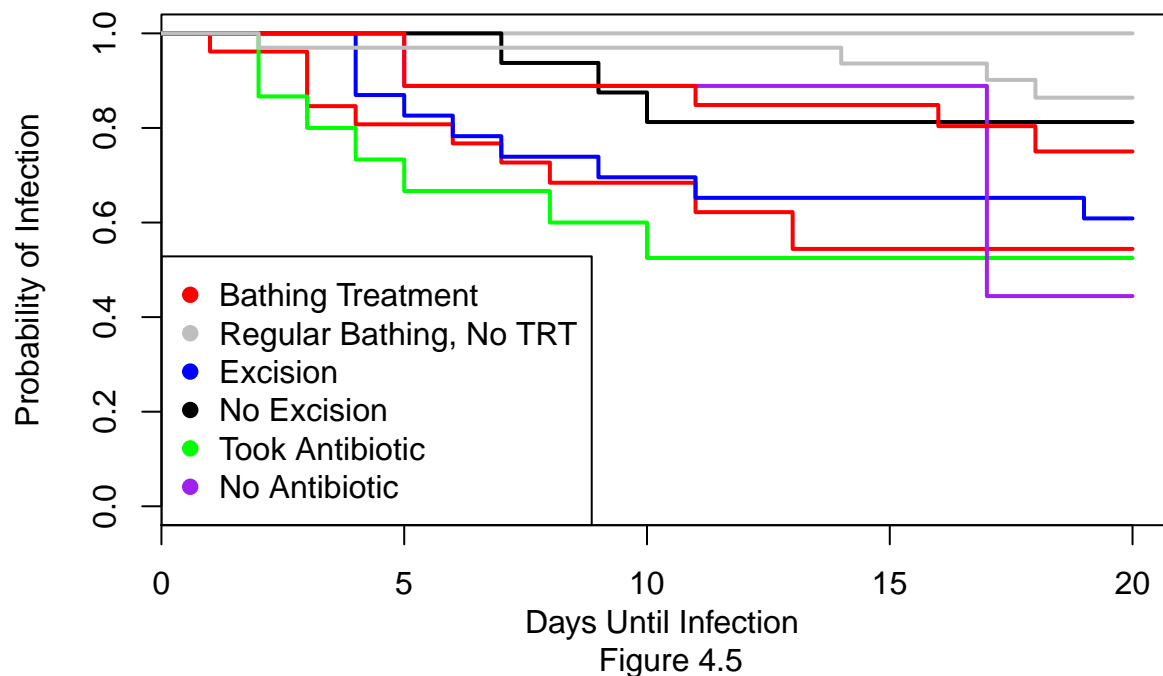
```
## Analysis of Deviance Table
## Cox model: response is Surv(tstart, tstop, D3)
## Terms added sequentially (first to last)
##
##           loglik   Chisq Df Pr(>|Chi|)
## NULL          -219.29
## D1            -216.44 5.7032  1  0.016934 *
## D2            -212.38 8.1085  1  0.004406 **
## D2:TimeGroup -212.06 0.6309  1  0.427032
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
beta2 <- coef(rets.ft)[3]
se.beta2 <- sqrt(vcov(rets.ft)[3,3])
exp( beta2 +c(-1.96, 1.96)*se.beta2 ) #getting ci for second coeff.
```

```
## [1] 0.4790238 5.2207153
```

```
plot(survfit(Surv(tstart,tstop,D3)~Z1+D1+D2,
data=burn2,
subset=(burn2$TimeGroup == "1")),
lwd=2, col=c("red","gray","blue","black","green","purple"),xlab="Days Until Infection \n Figure 4.5",ylab="Probability of Infection",
legend("bottomleft", legend = c("Bathing Treatment","Regular Bathing, No TRT","Excision","No Excision",
"Took Antibiotic","No Antibiotic"))
```

Recurrent Survival Function, Straphylococous Episode 1



```
plot(survfit(Surv(tstart,tstop,D3)~Z1,
data=burn2,
subset=(burn2$TimeGroup == "2")),
lwd=2, col=c("red","gray"),xlab="Days Until Infection \n Figure 4.6",ylab="Probability of Infection",main="Figure 4.6")
```

```
legend("bottomleft", legend = c("Bathing Treatment","Regular Bathing, No TRT"), col = c("red","gray","b
```

Recurrent Survival Function, Straphylococous Episode 2

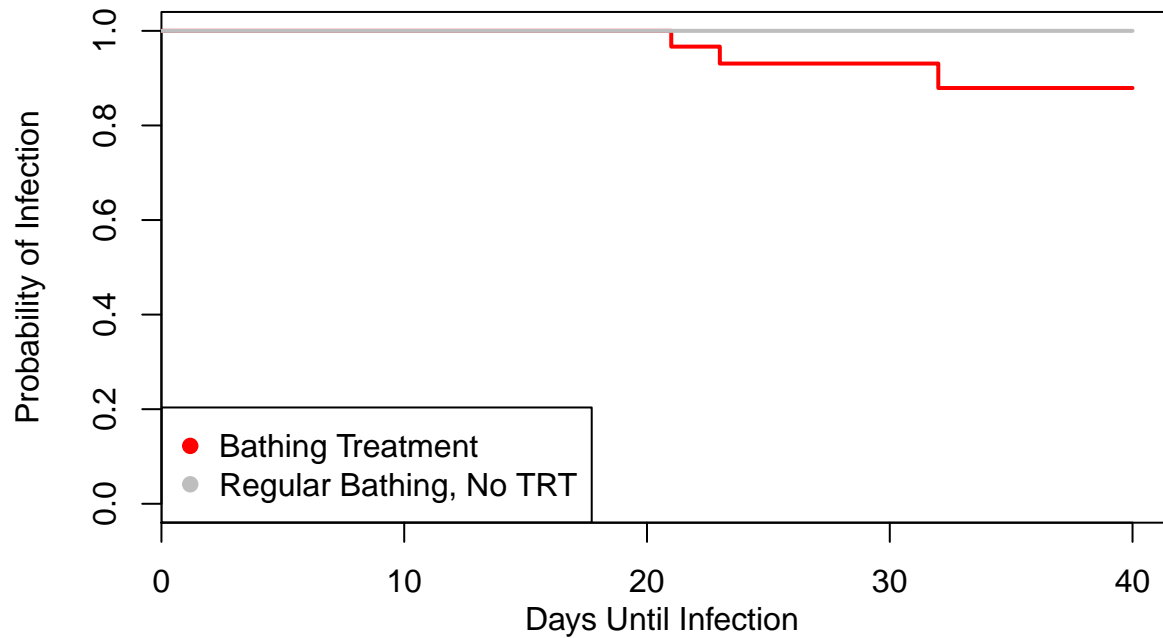


Figure 4.6

```
plot(survfit(Surv(tstart,tstop,D3)~D2,
data=burn2,
subset=(burn2$TimeGroup == "3")),
lwd=2, col=c("red","gray"),xlab="Days Until Infection \n Figure 4.7",ylab="Probability of Infection", m
legend("bottomleft", legend = c("Took Antibiotic","No Antibiotic"), col = c("red","gray"),pch=rep(19,2)
```

Recurrent Survival Function, Straphylococous Episode 3

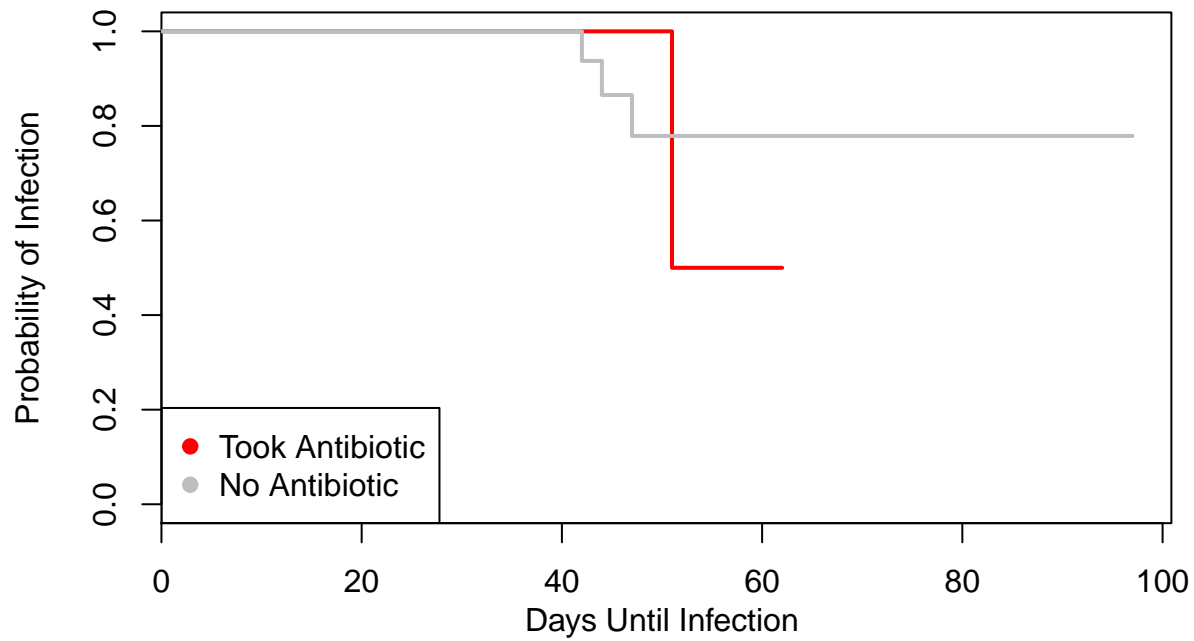


Figure 4.7

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

Below is the final model

$$h_i(t) = h_0(t) \times \exp[.539x_{1i} - 38.37x_{2i} + 19.1x_{3i} + 1.04x_{4i} + .0304x_{5i} + 18.27x_{6i} - 1.7732x_{1i}x_{5i} + 18.39x_{2i}x_{3i} + 18.79x_{2i}x_{5i} +$$