

R Notebook

```
##      treatment gender burn.percentage head buttock torso upper.leg lower.leg
## 1 bathing care   Man          15      0      0      1          1          0
## 2 bathing care   Man          20      0      0      1          0          0
## 3 bathing care   Man          15      0      0      0          1          1
## 4 bathing care   Man          20      1      0      1          0          0
## 5 bathing care   Man          70      1      1      1          1          0
## 6 bathing care   Man          20      1      0      1          0          0
##      respiratory.system burn.type time cens
## 1                      0   scalding  12    0
## 2                      0     flame   9    0
## 3                      0   scalding   7    1
## 4                      0   scalding  29    0
## 5                      0   scalding   4    1
## 6                      0     flame   8    1
```

Introduction

Description of the problem

It is generally known that infection is the chief reason for death and morbidity after burn injury, with it being responsible for 51% of the deaths, especially in the first 24h.

Burn wounds lack epidermis and circulation, so they are the best culture media with a centigrade temperature of 37 degrees. Therefore, they are the best media for bacterial growth. A few hours after the burn (normally 4-5 hours after) the wound surface becomes contaminated with many bacterial flora, which will start to grow and multiply, reaching the vascular and lymphatic vessels and starting to disperse. At this point, bacteraemia and sepsis start.

Usually the most frequent bacteria found in burn wound culture are *Staphylococcus* (55%), *Pseudomonas aeruginosa* (14.29%), *Enterococcus* (12.24%), *E. coli* (4%), *Klebsiella* and *Proteus* (both 2%).

Burn severity and the extent of burn injury are major risk factors for the development of infection in burn patients. Indeed burns that involve a larger surface area of the body, and burns that are deeper or more severe, are more likely to become infected.

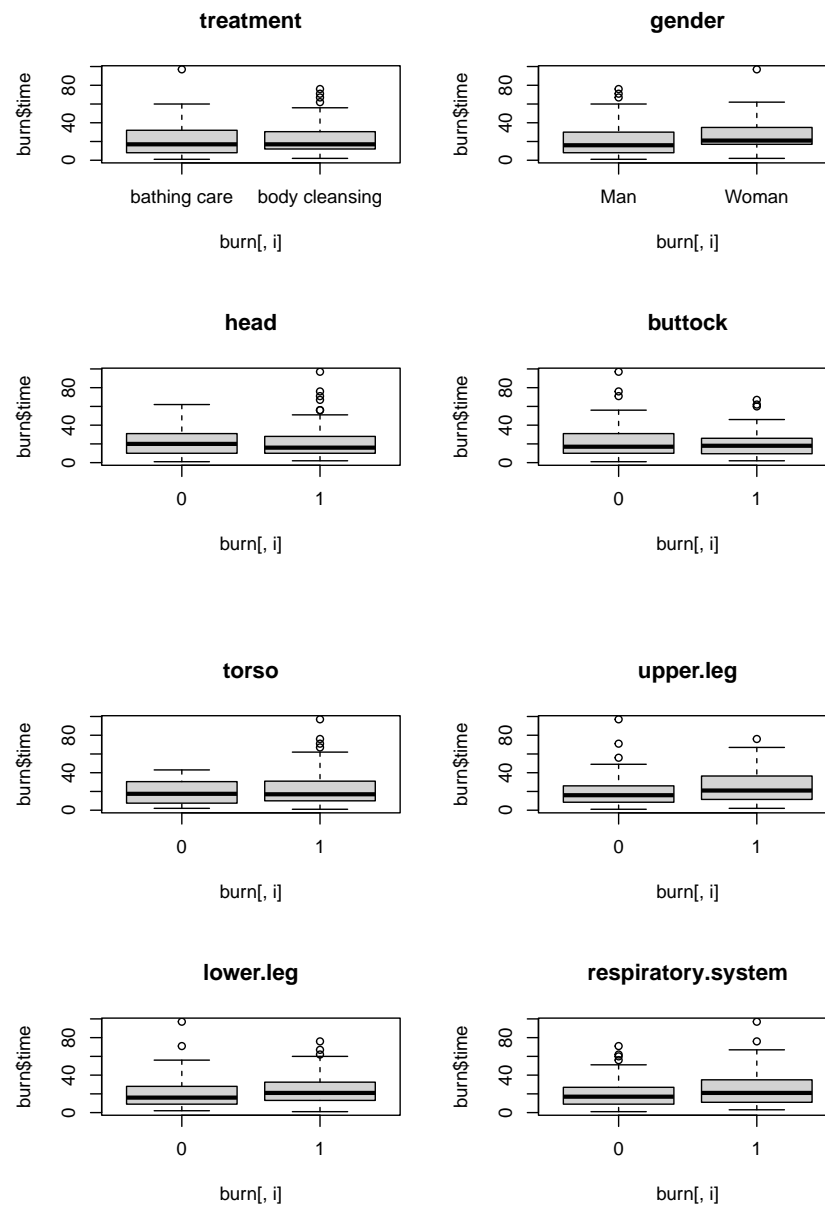
Additionally, burns caused by certain types of insults, such as chemical or electrical burns, may be at a higher risk of infection than burns caused by other types of insults, such as thermal burns.

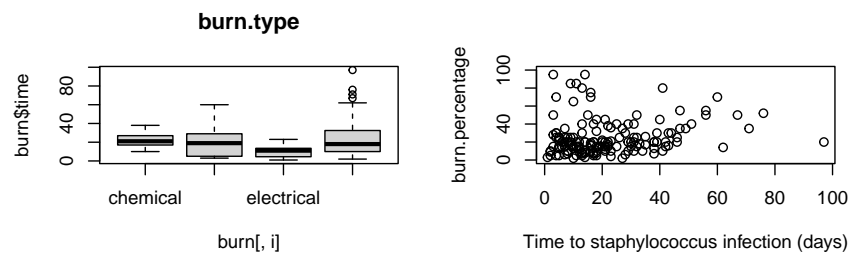
Goals

Our goal is to compare both burn treatments (“bathing care” and “body cleansing”) with respect to the time until a *Staphylococcus* infection.

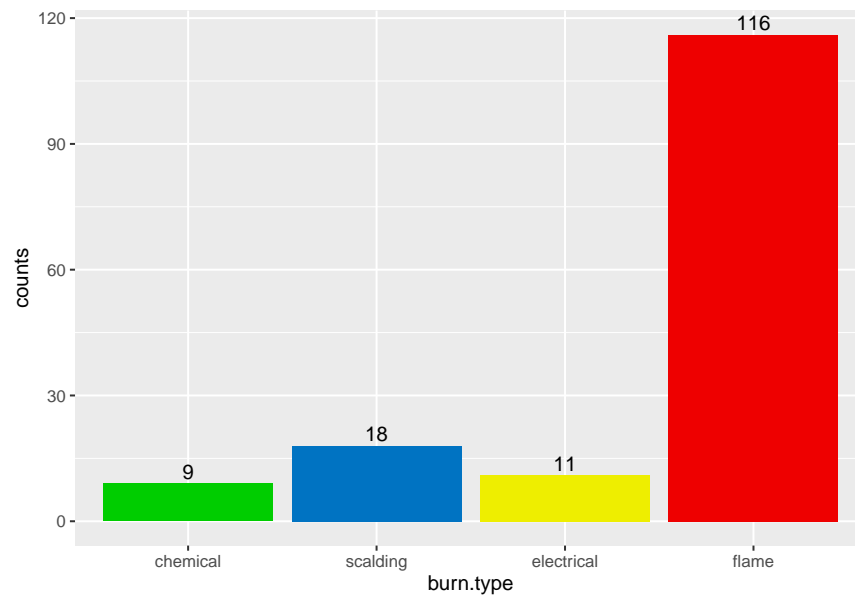
For that reason, we will focus on long time effect of an infection which has not been adequately treated or has not been treated on time.

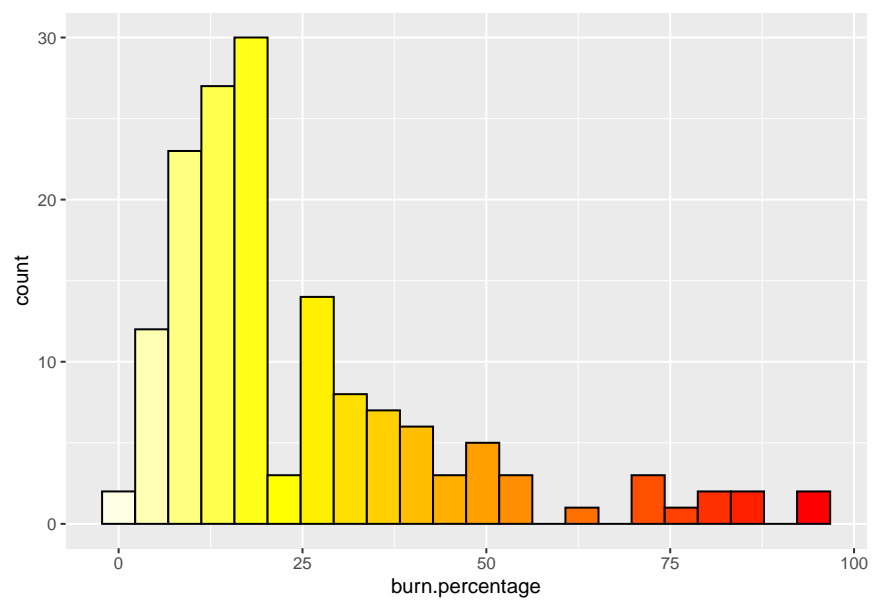
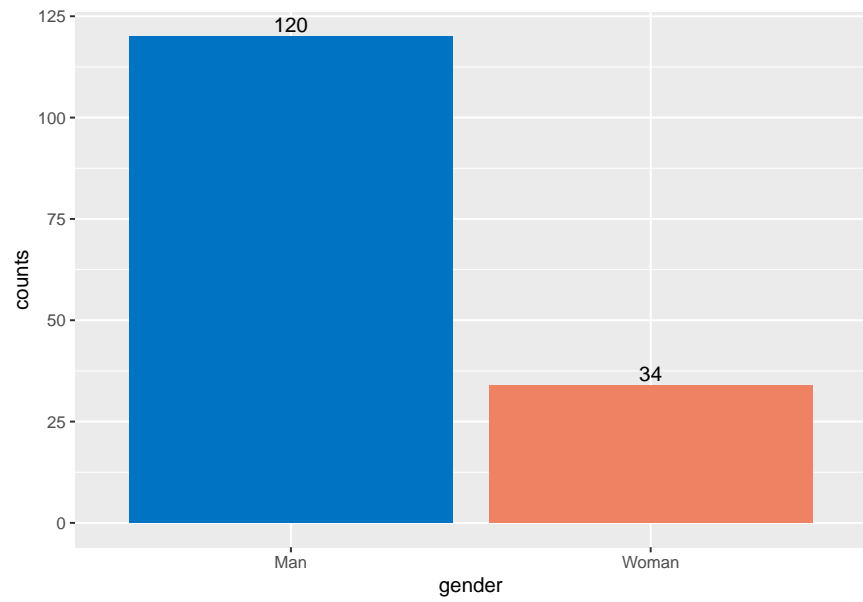
2) Descriptive analysis

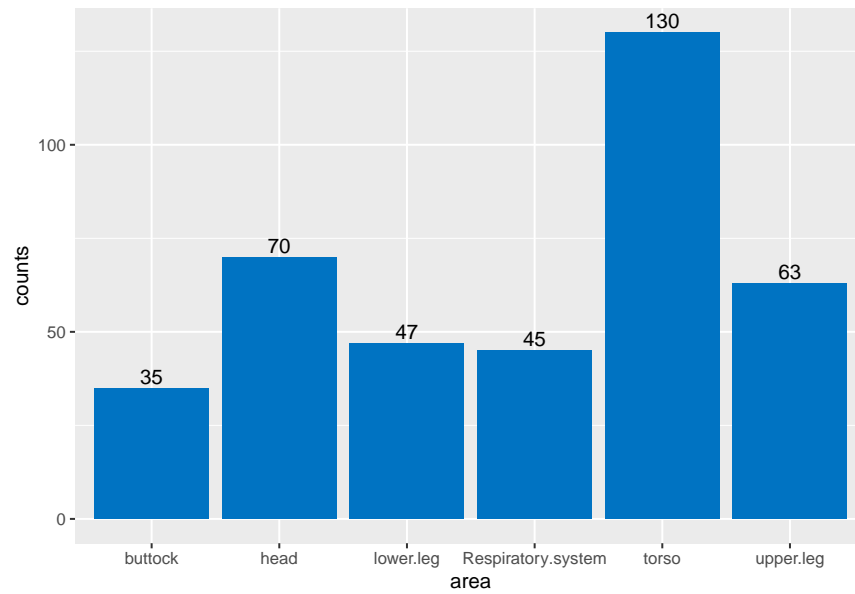




distribuzione dei livelli:

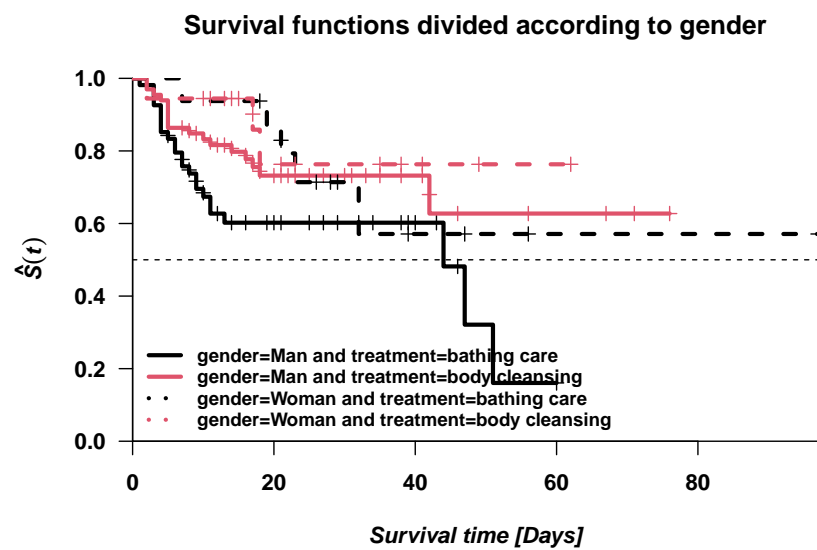




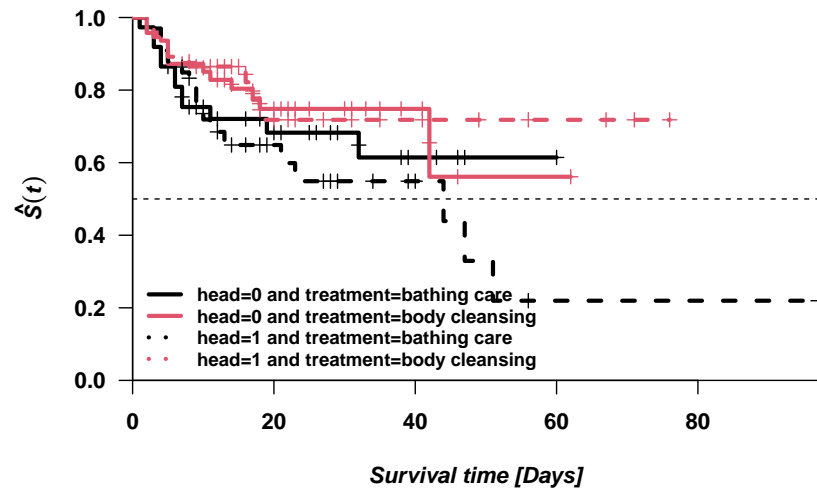


3) Nonparametric analysis

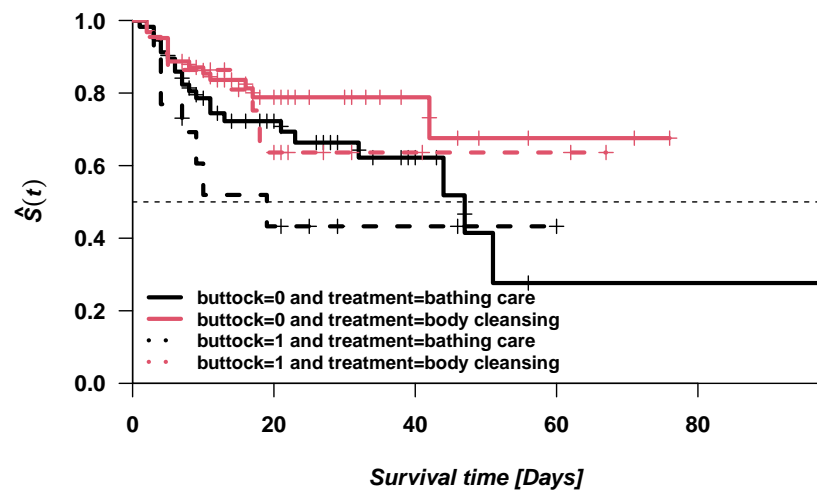
Estimation of the survival function



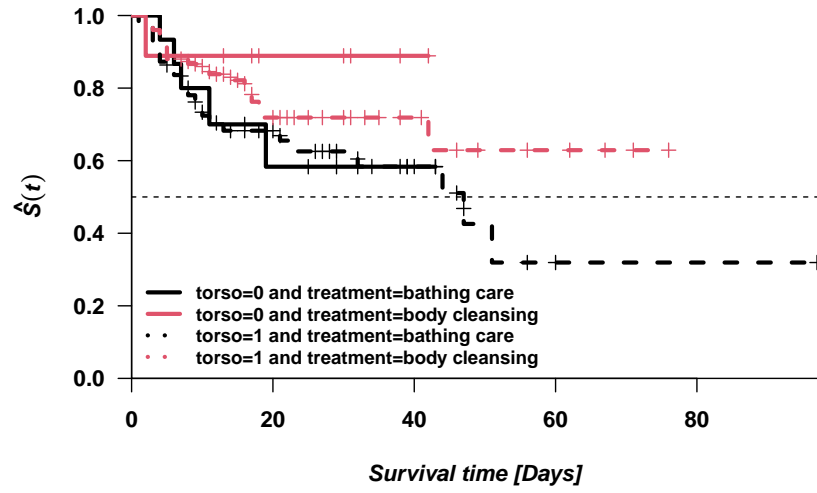
Survival functions divided according to head



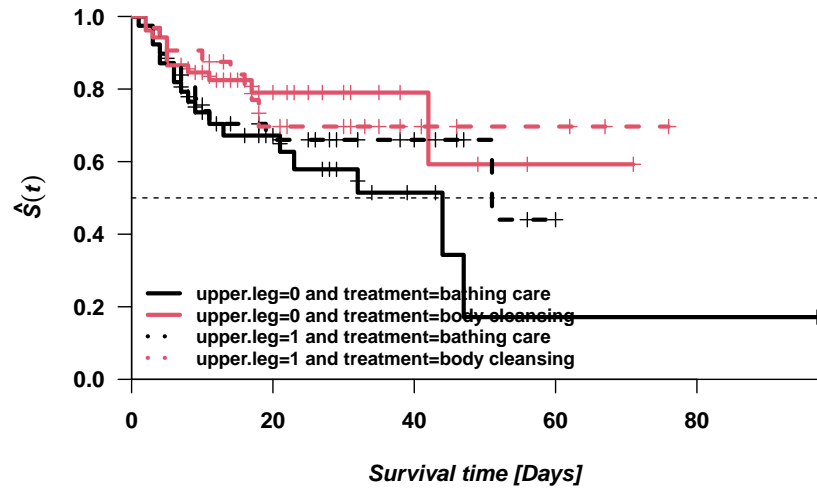
Survival functions divided according to buttock



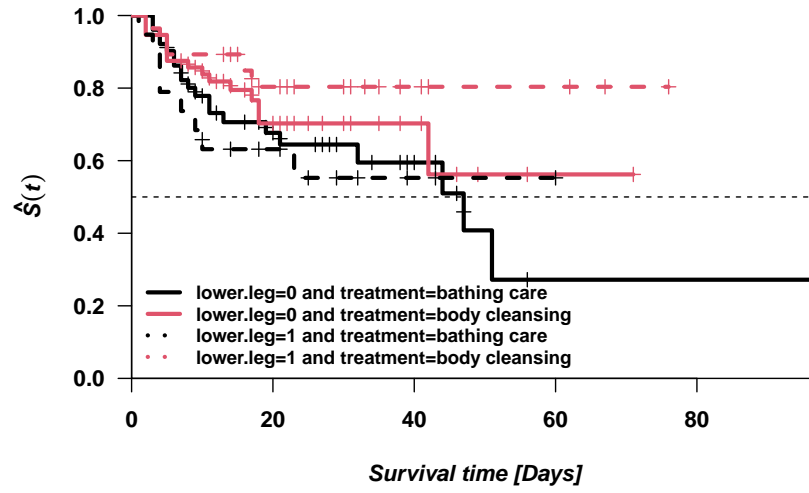
Survival functions divided according to torso



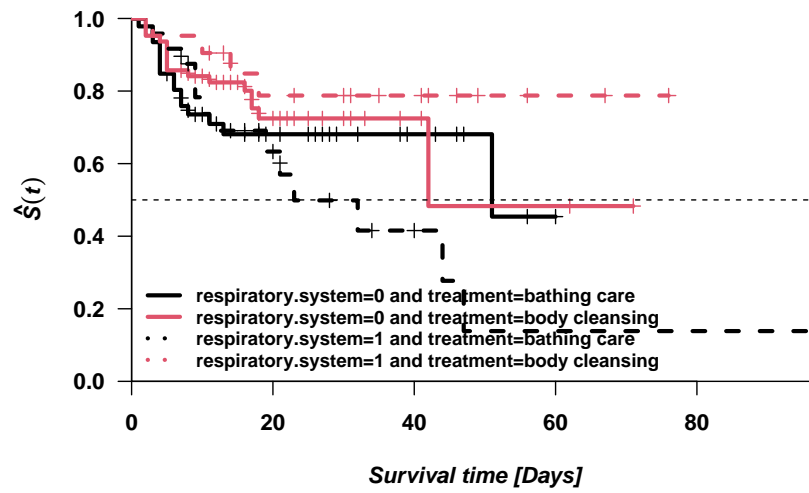
Survival functions divided according to upper.leg



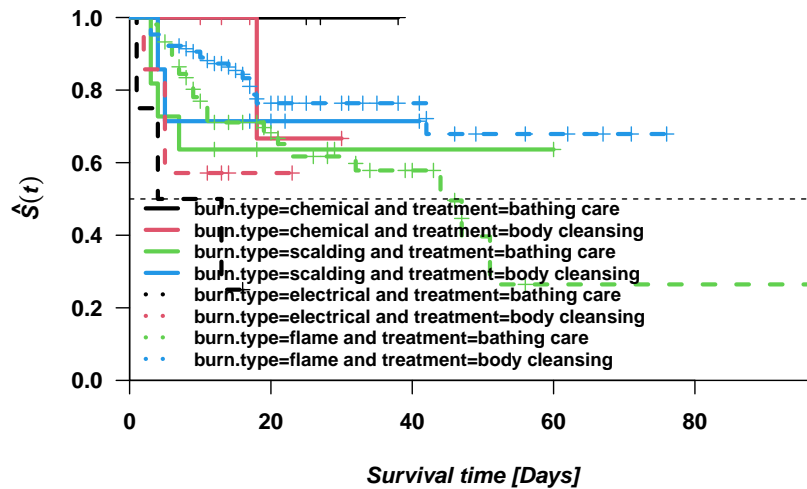
Survival functions divided according to lower.leg



Survival functions divided according to respiratory.system



Survival functions divided according to burn.type



Estimation of the median survival time

```
## Call: survfit(formula = Surv(time, cens) ~ covariata, data = burn)
##
##               n events median 0.95LCL 0.95UCL
## covariata=bathing care  70     28    47     32    NA
## covariata=body cleansing 84     20    NA     NA    NA
## Call: survfit(formula = Surv(time, cens) ~ covariata, data = burn)
##
##               n events median 0.95LCL 0.95UCL
## covariata=Man  120     40    47     44    NA
## covariata=Woman 34      8    NA     32    NA
## Call: survfit(formula = Surv(time, cens) ~ covariata, data = burn)
##
##               n events median 0.95LCL 0.95UCL
## covariata=0 84     24    NA     42    NA
## covariata=1 70     24    51     44    NA
## Call: survfit(formula = Surv(time, cens) ~ covariata, data = burn)
##
##               n events median 0.95LCL 0.95UCL
## covariata=0 119     34    51     44    NA
## covariata=1 35     14    NA     18    NA
## Call: survfit(formula = Surv(time, cens) ~ covariata, data = burn)
##
##               n events median 0.95LCL 0.95UCL
## covariata=0 24      6    NA     NA    NA
## covariata=1 130     42    51     44    NA
## Call: survfit(formula = Surv(time, cens) ~ covariata, data = burn)
##
##               n events median 0.95LCL 0.95UCL
## covariata=0 91     28    44     42    NA
## covariata=1 63     20    NA     51    NA
## Call: survfit(formula = Surv(time, cens) ~ covariata, data = burn)
```

```
##
##           n events median 0.95LCL 0.95UCL
## covariata=0 107      35      47      42      NA
## covariata=1  47      13      NA      NA      NA
## Call: survfit(formula = Surv(time, cens) ~ covariata, data = burn)
##
##           n events median 0.95LCL 0.95UCL
## covariata=0 109      31      NA      51      NA
## covariata=1  45      17      47      32      NA
## Call: survfit(formula = Surv(time, cens) ~ covariata, data = burn)
##
##           n events median 0.95LCL 0.95UCL
## covariata=chemical      9      1      NA      NA      NA
## covariata=scalding     18      6      NA      7      NA
## covariata=electrical    11      6      13      5      NA
## covariata=flame       116     35      51     44      NA
```

DA MODIFICARE

Comparison of survival functions by means of nonparametric tests such as the logrank test.

SCRIVERE CON LATEX QUALE TEST VOGLIAMO FARE

We use an (extended) Gehan test, which puts more weight on the smallest observations, to verify if the two survival functions are similar at the beginning.

```
## Call:
## survdiff(formula = formula, rho = 1)
##
##           N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care, gender=Man    54    19.58    12.57    3.903    6.730
## treatment=bathing care, gender=Woman  16     3.67     5.36    0.529    0.747
## treatment=body cleansing, gender=Man   66    14.65    17.39    0.431    0.900
## treatment=body cleansing, gender=Woman 18     2.49     5.07    1.315    1.793
##
## Chisq= 7.4  on 3 degrees of freedom, p= 0.06
```

```
## Call:
## survdiff(formula = formula, rho = 1)
##
##           N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care, head=0    37    10.5     9.22    0.187    0.287
## treatment=bathing care, head=1    33    12.7     8.71    1.845    2.812
## treatment=body cleansing, head=0   47    10.2    12.53    0.421    0.727
## treatment=body cleansing, head=1   37     6.9     9.93    0.922    1.464
##
## Chisq= 4  on 3 degrees of freedom, p= 0.3
```

```
## Call:
## survdiff(formula = formula, rho = 1)
##
##           N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care, buttock=0   57    17.15    14.86    0.35269    0.6635
```

```

## treatment=bathing care, buttock=1 13 6.10 3.07 2.99512 3.8532
## treatment=body cleansing, buttock=0 62 11.27 16.42 1.61412 3.2299
## treatment=body cleansing, buttock=1 22 5.86 6.04 0.00492 0.0069
##
## Chisq= 5.9 on 3 degrees of freedom, p= 0.1

## Call:
## survdiff(formula = formula, rho = 1)
##
##
## N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care, torso=0 15 4.210 3.45 0.168 0.214
## treatment=bathing care, torso=1 55 19.042 14.48 1.436 2.678
## treatment=body cleansing, torso=0 9 0.994 2.41 0.832 1.049
## treatment=body cleansing, torso=1 75 16.146 20.05 0.761 1.795
##
## Chisq= 3.8 on 3 degrees of freedom, p= 0.3

## Call:
## survdiff(formula = formula, rho = 1)
##
##
## N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care, upper.leg=0 39 14.00 9.43 2.2074 3.405
## treatment=bathing care, upper.leg=1 31 9.25 8.50 0.0675 0.103
## treatment=body cleansing, upper.leg=0 52 9.69 13.04 0.8615 1.510
## treatment=body cleansing, upper.leg=1 32 7.45 9.42 0.4117 0.645
##
## Chisq= 4.2 on 3 degrees of freedom, p= 0.2

## Call:
## survdiff(formula = formula, rho = 1)
##
##
## N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care, lower.leg=0 51 16.17 13.31 0.614 1.091
## treatment=bathing care, lower.leg=1 19 7.08 4.62 1.314 1.759
## treatment=body cleansing, lower.leg=0 56 12.78 14.26 0.153 0.281
## treatment=body cleansing, lower.leg=1 28 4.36 8.20 1.800 2.714
##
## Chisq= 4.6 on 3 degrees of freedom, p= 0.2

## Call:
## survdiff(formula = formula, rho = 1)
##
##
## N Observed Expected (O-E)^2/E
## treatment=bathing care, respiratory.system=0 46 13.2 11.52 0.241
## treatment=bathing care, respiratory.system=1 24 10.1 6.41 2.082
## treatment=body cleansing, respiratory.system=0 63 13.8 15.72 0.227
## treatment=body cleansing, respiratory.system=1 21 3.3 6.74 1.750
##
## (O-E)^2/V
## treatment=bathing care, respiratory.system=0 0.402
## treatment=bathing care, respiratory.system=1 2.937
## treatment=body cleansing, respiratory.system=0 0.445
## treatment=body cleansing, respiratory.system=1 2.583
##
## Chisq= 5.2 on 3 degrees of freedom, p= 0.2

```

```
## Call:
## survdiff(formula = formula, rho = 1)
##
##
##      N Observed Expected (O-E)^2/E
## treatment=bathing care, burn.type=chemical      3      0.000      0.964      0.9641
## treatment=bathing care, burn.type=scalding     11      3.760      2.624      0.4916
## treatment=bathing care, burn.type=electrical      4      2.729      0.560      8.3962
## treatment=bathing care, burn.type=flame        52     16.763     13.782      0.6445
## treatment=body cleansing, burn.type=chemical      6      0.738      1.583      0.4506
## treatment=body cleansing, burn.type=scalding      7      1.864      1.699      0.0159
## treatment=body cleansing, burn.type=electrical     7      2.825      1.267      1.9151
## treatment=body cleansing, burn.type=flame       64     11.713     17.911      2.1450
##
##      (O-E)^2/V
## treatment=bathing care, burn.type=chemical      1.1843
## treatment=bathing care, burn.type=scalding      0.6267
## treatment=bathing care, burn.type=electrical     9.6063
## treatment=bathing care, burn.type=flame          1.1677
## treatment=body cleansing, burn.type=chemical     0.5471
## treatment=body cleansing, burn.type=scalding      0.0194
## treatment=body cleansing, burn.type=electrical    2.2548
## treatment=body cleansing, burn.type=flame        4.5892
##
## Chisq= 17.3 on 7 degrees of freedom, p= 0.02
```

With these data, a stratified test might be a good idea, because of the unbalanced design of the experiment and because our ultimate goal is the one to verify the effect of each treatment to intervene in a specific medical situation (with specific burn locations and percentage of body burnt)

```
## Call:
## survdiff(formula = formula)
##
##
##      N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care    70      28     21.1      2.23      4.13
## treatment=body cleansing  84      20     26.9      1.75      4.13
##
## Chisq= 4.1 on 1 degrees of freedom, p= 0.04
```

```
## Call:
## survdiff(formula = formula)
##
##
##      N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care    70      28     21.5      1.99      3.66
## treatment=body cleansing  84      20     26.5      1.61      3.66
##
## Chisq= 3.7 on 1 degrees of freedom, p= 0.06
```

```
## Call:
## survdiff(formula = formula)
##
##
##      N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care    70      28     20.9      2.43      4.46
```

```
## treatment=body cleansing 84      20      27.1      1.87      4.46
##
## Chisq= 4.5 on 1 degrees of freedom, p= 0.03
```

```
## Call:
## survdiff(formula = formula)
##
##              N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care  70      28    21.4      2.05      3.82
## treatment=body cleansing 84      20    26.6      1.65      3.82
##
## Chisq= 3.8 on 1 degrees of freedom, p= 0.05
```

```
## Call:
## survdiff(formula = formula)
##
##              N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care  70      28    21.2      2.16      3.96
## treatment=body cleansing 84      20    26.8      1.71      3.96
##
## Chisq= 4 on 1 degrees of freedom, p= 0.05
```

```
## Call:
## survdiff(formula = formula)
##
##              N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care  70      28     22      1.61      3.09
## treatment=body cleansing 84      20     26      1.37      3.09
##
## Chisq= 3.1 on 1 degrees of freedom, p= 0.08
```

```
## Call:
## survdiff(formula = formula)
##
##              N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care  70      28    20.9      2.42      4.44
## treatment=body cleansing 84      20    27.1      1.87      4.44
##
## Chisq= 4.4 on 1 degrees of freedom, p= 0.04
```

```
## Call:
## survdiff(formula = formula)
##
##              N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care, burn.type=chemical      3      0    1.150  1.149505
## treatment=bathing care, burn.type=scalding     11      4    3.140  0.235789
## treatment=bathing care, burn.type=electrical     4      3    0.622  9.093670
## treatment=bathing care, burn.type=flame        52     21   16.446  1.261250
## treatment=body cleansing, burn.type=chemical     6      1    1.824  0.372524
## treatment=body cleansing, burn.type=scalding     7      2    1.969  0.000479
## treatment=body cleansing, burn.type=electrical    7      3    1.419  1.760065
## treatment=body cleansing, burn.type=flame       64     14   21.430  2.576200
##              (O-E)^2/V
```

```

## treatment=bathing care, burn.type=chemical      1.19994
## treatment=bathing care, burn.type=scalding      0.25642
## treatment=bathing care, burn.type=electrical    9.42507
## treatment=bathing care, burn.type=flame         1.96004
## treatment=body cleansing, burn.type=chemical    0.39576
## treatment=body cleansing, burn.type=scalding    0.00051
## treatment=body cleansing, burn.type=electrical  1.86055
## treatment=body cleansing, burn.type=flame       4.73667
##
##  Chisq= 16.8  on 7 degrees of freedom, p= 0.02

## Call:
## survdiff(formula = formula, rho = 1)
##
##               N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care  70      23.3    17.9      1.60      3.48
## treatment=body cleansing 84      17.1    22.5      1.28      3.48
##
##  Chisq= 3.5  on 1 degrees of freedom, p= 0.06

## Call:
## survdiff(formula = formula, rho = 1)
##
##               N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care  70      23.2    18.0      1.50      3.22
## treatment=body cleansing 84      17.2    22.4      1.21      3.22
##
##  Chisq= 3.2  on 1 degrees of freedom, p= 0.07

## Call:
## survdiff(formula = formula, rho = 1)
##
##               N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care  70      23.3    17.6      1.87      3.99
## treatment=body cleansing 84      17.0    22.8      1.44      3.99
##
##  Chisq= 4  on 1 degrees of freedom, p= 0.05

## Call:
## survdiff(formula = formula, rho = 1)
##
##               N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care  70      23.4    18.0      1.60      3.49
## treatment=body cleansing 84      17.1    22.5      1.28      3.49
##
##  Chisq= 3.5  on 1 degrees of freedom, p= 0.06

## Call:
## survdiff(formula = formula, rho = 1)
##
##               N Observed Expected (O-E)^2/E (O-E)^2/V
## treatment=bathing care  70      23.3    17.9      1.64      3.5
## treatment=body cleansing 84      17.2    22.6      1.30      3.5

```

```
##
## Chisq= 3.5 on 1 degrees of freedom, p= 0.06

## Call:
## survdiff(formula = formula, rho = 1)
##
##
```

	N	Observed	Expected	(O-E) ² /E	(O-E) ² /V
treatment=bathing care	70	23.1	18.3	1.28	2.82
treatment=body cleansing	84	17.2	22.0	1.06	2.82

```
##
## Chisq= 2.8 on 1 degrees of freedom, p= 0.09

## Call:
## survdiff(formula = formula, rho = 1)
##
##
```

	N	Observed	Expected	(O-E) ² /E	(O-E) ² /V
treatment=bathing care	70	23.4	17.7	1.86	3.95
treatment=body cleansing	84	17.2	22.9	1.43	3.95

```
##
## Chisq= 4 on 1 degrees of freedom, p= 0.05

## Call:
## survdiff(formula = formula, rho = 1)
##
##
```

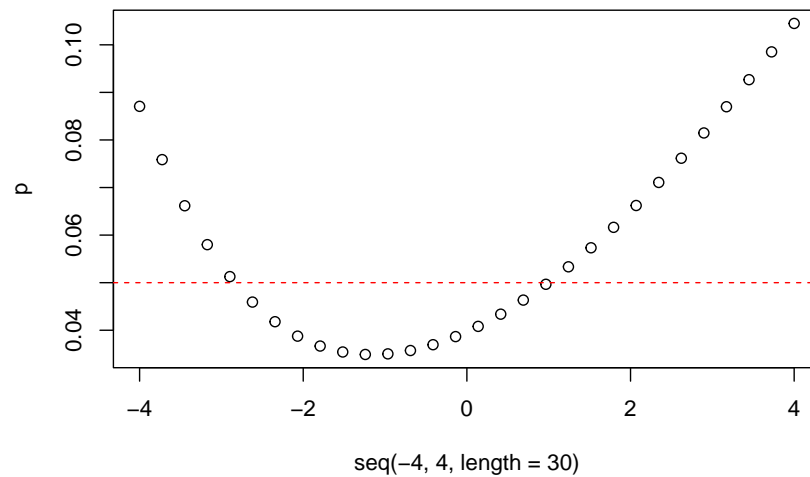
	N	Observed	Expected	(O-E) ² /E
treatment=bathing care, burn.type=chemical	3	0.000	0.964	0.9641
treatment=bathing care, burn.type=scalding	11	3.760	2.624	0.4916
treatment=bathing care, burn.type=electrical	4	2.729	0.560	8.3962
treatment=bathing care, burn.type=flame	52	16.763	13.782	0.6445
treatment=body cleansing, burn.type=chemical	6	0.738	1.583	0.4506
treatment=body cleansing, burn.type=scalding	7	1.864	1.699	0.0159
treatment=body cleansing, burn.type=electrical	7	2.825	1.267	1.9151
treatment=body cleansing, burn.type=flame	64	11.713	17.911	2.1450

```
##
## (O-E)2/V
## treatment=bathing care, burn.type=chemical 1.1843
## treatment=bathing care, burn.type=scalding 0.6267
## treatment=bathing care, burn.type=electrical 9.6063
## treatment=bathing care, burn.type=flame 1.1677
## treatment=body cleansing, burn.type=chemical 0.5471
## treatment=body cleansing, burn.type=scalding 0.0194
## treatment=body cleansing, burn.type=electrical 2.2548
## treatment=body cleansing, burn.type=flame 4.5892
##
## Chisq= 17.3 on 7 degrees of freedom, p= 0.02

## Call:
## survdiff(formula = formula, rho = 1)
##
##
```

	N	Observed	Expected	(O-E) ² /E	(O-E) ² /V
treatment=bathing care	70	25.0	20.8	0.854	3.84
treatment=body cleansing	84	17.8	22.0	0.807	3.84

```
##
## Chisq= 3.8 on 1 degrees of freedom, p= 0.05
```



```
## [1] -1.241379
```

```
## Call:
```

```
## survdiff(formula = formula, rho = -1)
```

```
##
```

```
##           N Observed Expected (O-E)^2/E (O-E)^2/V
```

```
## treatment=bathing care    70     32.8     27.2      1.15      4.45
```

```
## treatment=body cleansing  84     24.5     30.1      1.04      4.45
```

```
##
```

```
## Chisq= 4.4  on 1 degrees of freedom, p= 0.03
```

4) Fit of a parametric survival model

Fit of a Weibull, log-logistic, or lognormal model.

Interpretation of the model fit.

Interpretation of the model parameters in terms of relative hazards or relative odds, and the accelerating factor.

5) Fit of a semi-parametric model

Fit of the proportional hazards models.

Interpretation of the model fit.

Interpretation of the model parameters in terms of relative hazards.

Analysis of the residuals to check the model's goodness-of-fit.

6) Conclusions