HW_3

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```
#####
## 6.2. For the covariates with complete data (in Columns 1-22), use stepwise regre
ssion with AIC to identify the best model for (a) overall survival, and (b) recurre
nce-free survival.
#####
library(survival)
library(asaur)
library(MASS)
attach (hepatoCellular)
head(hepatoCellular[, 1:8])

##   Number Age Gender HBsAg Cirrhosis ALT AST AFP
## 1      1  57      0     1         1   1   2   2
## 2      2  58      1     0         0   1   1   2
## 3      3  65      1     0         0   1   1   2
## 4      4  54      1     1         0   2   1   2
## 5      5  71      1     1         0   2   2   2
## 6      6  32      1     0         0   2   2   2

head(hepatoCellular[, 9:13])

##   Tumorsize Tumordifferentiation Vascularinvasion Tumormultiplicity Capsulation
## 1         2                    1                0                 1           0
## 2         1                    1                0                 1           1
## 3         2                    2                1                 1           1
## 4         2                    2                0                 1           1
## 5         2                    2                1                 2           0
## 6         2                    2                0                 1           0

head(hepatoCellular[, 14:22])

##   TNM BCLC OS Death RFS Recurrence    CXCL17T    CXCL17P    CXCL17N
## 1   2    1 83     0  13          1 113.947238 299.325404 138.247177
## 2   1    1 81     0  81          0  54.071542  63.468462   6.214912
## 3   2    2 79     0  79          0  22.188831  34.470336  22.131934
## 4   1    1 76     0  76          0   8.442809  16.002843  11.146906
## 5   2    2  7     1   3          1   8.271131  22.034540  32.271196
## 6   1    1 13     1   3          1  13.708073   6.423604   0.000000
```

(a) overall survival

With RFS Included

```
modelAll1.coxph <- coxph(Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + ALT +AST + AFP
```

```
+ Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormultiplicity + Capsula
tion + TNM + BCLC + RFS + Recurrence + CXCL17T +  CXCL17P + CXCL17N)

## Warning in coxph.fit(X, Y, istrat, offset, init, control, weights = weights, :
## Loglik converged before variable 15 ; coefficient may be infinite.

result.step1 <-suppressWarnings(step(modelAll1.coxph, scope=list(upper=~  Age + HBs
Ag + Cirrhosis + ALT +AST + AFP+ Tumorsize + Tumordifferentiation + Vascularinvasio
n + Tumormultiplicity + Capsulation + TNM + BCLC + RFS + Recurrence + CXCL17T +  CX
CL17P + CXCL17N, lower=~Age)))

## Start:  AIC=818.36
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AST + AFP +
##     Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##     Capsulation + TNM + BCLC + RFS + Recurrence + CXCL17T + CXCL17P +
##     CXCL17N
##
##                          Df    AIC
## - AST                     1 816.36
## - Tumormultiplicity       1 816.40
## - ALT                     1 816.49
## - CXCL17T                 1 816.59
## - CXCL17N                 1 816.64
## - Capsulation             1 816.88
## - TNM                     1 816.95
## - BCLC                    1 817.26
## - Cirrhosis               1 817.49
## <none>                      818.36
## - AFP                     1 819.21
## - CXCL17P                 1 819.51
## - HBsAg                   1 819.57
## - Tumordifferentiation    1 819.98
## - Tumorsize               1 820.63
## - Vascularinvasion        1 821.04
## - Recurrence              1 829.41
## - RFS                     1 841.35
##
## Step:  AIC=816.36
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AFP + Tumorsize +
##     Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##     Capsulation + TNM + BCLC + RFS + Recurrence + CXCL17T + CXCL17P +
##     CXCL17N
##
##                          Df    AIC
## - Tumormultiplicity       1 814.40
## - ALT                     1 814.51
## - CXCL17T                 1 814.60
## - CXCL17N                 1 814.65
## - Capsulation             1 814.89
## - TNM                     1 814.95
```

```
## - BCLC                    1 815.26
## - Cirrhosis               1 815.49
## <none>                      816.36
## - AFP                     1 817.24
## - CXCL17P                 1 817.55
## - HBsAg                   1 817.57
## - Tumordifferentiation    1 818.05
## + AST                     1 818.36
## - Tumorsize               1 818.72
## - Vascularinvasion        1 819.06
## - Recurrence              1 827.47
## - RFS                     1 839.39
##
## Step:  AIC=814.4
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AFP + Tumorsize +
##     Tumordifferentiation + Vascularinvasion + Capsulation + TNM +
##     BCLC + RFS + Recurrence + CXCL17T + CXCL17P + CXCL17N
##
##                            Df    AIC
## - ALT                     1 812.53
## - CXCL17T                 1 812.62
## - CXCL17N                 1 812.71
## - Capsulation             1 812.97
## - TNM                     1 812.99
## - Cirrhosis               1 813.50
## - BCLC                    1 814.20
## <none>                      814.40
## - HBsAg                   1 815.57
## - CXCL17P                 1 815.61
## - AFP                     1 815.62
## - Tumordifferentiation    1 816.05
## + Tumormultiplicity       1 816.36
## + AST                     1 816.40
## - Tumorsize               1 816.80
## - Vascularinvasion        1 817.48
## - Recurrence              1 825.48
## - RFS                     1 837.99
##
## Step:  AIC=812.53
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + AFP + Tumorsize +
##     Tumordifferentiation + Vascularinvasion + Capsulation + TNM +
##     BCLC + RFS + Recurrence + CXCL17T + CXCL17P + CXCL17N
##
##                            Df    AIC
## - CXCL17T                 1 810.76
## - CXCL17N                 1 810.81
## - TNM                     1 811.05
## - Capsulation             1 811.07
## - Cirrhosis               1 811.69
## - BCLC                    1 812.53
```

```
## <none>                          812.53
## - CXCL17P                     1 813.70
## - HBsAg                       1 813.83
## - AFP                         1 813.87
## - Tumordifferentiation        1 814.22
## + ALT                         1 814.40
## + Tumormultiplicity           1 814.51
## + AST                         1 814.51
## - Tumorsize                   1 814.82
## - Vascularinvasion            1 815.49
## - Recurrence                  1 823.73
## - RFS                         1 836.20
##
## Step:  AIC=810.76
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + AFP + Tumorsize +
##      Tumordifferentiation + Vascularinvasion + Capsulation + TNM +
##      BCLC + RFS + Recurrence + CXCL17P + CXCL17N
##
##                            Df    AIC
## - CXCL17N                     1 809.26
## - Capsulation                 1 809.33
## - TNM                         1 809.34
## - Cirrhosis                   1 809.95
## <none>                          810.76
## - BCLC                        1 811.14
## - CXCL17P                     1 811.73
## - HBsAg                       1 811.89
## + CXCL17T                     1 812.53
## - Tumordifferentiation        1 812.55
## + ALT                         1 812.62
## - AFP                         1 812.64
## + Tumormultiplicity           1 812.75
## + AST                         1 812.76
## - Tumorsize                   1 813.07
## - Vascularinvasion            1 813.54
## - Recurrence                  1 822.05
## - RFS                         1 834.45
##
## Step:  AIC=809.26
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + AFP + Tumorsize +
##      Tumordifferentiation + Vascularinvasion + Capsulation + TNM +
##      BCLC + RFS + Recurrence + CXCL17P
##
##                            Df    AIC
## - TNM                         1 807.72
## - Capsulation                 1 807.87
## - Cirrhosis                   1 808.30
## <none>                          809.26
## - BCLC                        1 809.46
## - CXCL17P                     1 810.11
```

```
## - HBsAg                    1 810.32
## - AFP                      1 810.73
## + CXCL17N                  1 810.76
## + CXCL17T                  1 810.81
## - Tumordifferentiation    1 810.95
## + ALT                      1 811.18
## + Tumormultiplicity       1 811.22
## + AST                      1 811.23
## - Tumorsize                1 811.26
## - Vascularinvasion        1 812.13
## - Recurrence               1 820.98
## - RFS                      1 832.49
##
## Step:  AIC=807.72
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + AFP + Tumorsize +
##     Tumordifferentiation + Vascularinvasion + Capsulation + BCLC +
##     RFS + Recurrence + CXCL17P
##
##                            Df    AIC
## - Capsulation              1 806.37
## - Cirrhosis                1 806.61
## - BCLC                     1 807.46
## <none>                       807.72
## - CXCL17P                  1 808.16
## - AFP                      1 808.87
## - HBsAg                    1 809.14
## + CXCL17T                  1 809.23
## + TNM                      1 809.26
## - Tumorsize                1 809.29
## + CXCL17N                  1 809.34
## - Tumordifferentiation    1 809.61
## + Tumormultiplicity       1 809.68
## + ALT                      1 809.69
## + AST                      1 809.71
## - Vascularinvasion        1 810.77
## - Recurrence               1 820.39
## - RFS                      1 831.37
##
## Step:  AIC=806.37
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + AFP + Tumorsize +
##     Tumordifferentiation + Vascularinvasion + BCLC + RFS + Recurrence +
##     CXCL17P
##
##                            Df    AIC
## - Cirrhosis                1 805.16
## - BCLC                     1 806.18
## <none>                       806.37
## - CXCL17P                  1 806.96
## + Capsulation              1 807.72
## - Tumordifferentiation    1 807.73
```

```
## - Tumorsize               1 807.78
## + CXCL17T               1 807.80
## - AFP                   1 807.86
## + TNM                   1 807.87
## + CXCL17N               1 807.95
## + Tumormultiplicity     1 808.27
## - HBsAg                 1 808.33
## + AST                   1 808.34
## + ALT                   1 808.36
## - Vascularinvasion      1 808.94
## - Recurrence            1 818.65
## - RFS                   1 832.12
##
## Step:  AIC=805.16
## Surv(OS, Death) ~ Age + HBsAg + AFP + Tumorsize + Tumordifferentiation +
##     Vascularinvasion + BCLC + RFS + Recurrence + CXCL17P
##
##                          Df    AIC
## - BCLC                   1 804.95
## <none>                     805.16
## - CXCL17P                1 805.60
## - Tumorsize              1 806.14
## + Cirrhosis              1 806.37
## - AFP                    1 806.38
## - HBsAg                  1 806.45
## + Capsulation            1 806.61
## + CXCL17T                1 806.63
## + TNM                    1 806.82
## + CXCL17N                1 806.83
## - Tumordifferentiation   1 806.95
## + Tumormultiplicity      1 807.12
## + ALT                    1 807.13
## + AST                    1 807.13
## - Vascularinvasion       1 807.65
## - Recurrence             1 817.79
## - RFS                    1 830.23
##
## Step:  AIC=804.95
## Surv(OS, Death) ~ Age + HBsAg + AFP + Tumorsize + Tumordifferentiation +
##     Vascularinvasion + RFS + Recurrence + CXCL17P
##
##                          Df    AIC
## - CXCL17P                1 804.72
## <none>                     804.95
## + BCLC                   1 805.16
## + Tumormultiplicity      1 805.91
## - HBsAg                  1 805.98
## + CXCL17T                1 806.03
## - Tumordifferentiation   1 806.08
## + Cirrhosis              1 806.18
```

```
## + Capsulation         1 806.32
## + CXCL17N             1 806.65
## + ALT                 1 806.71
## + AST                 1 806.84
## - AFP                 1 806.90
## + TNM                 1 806.94
## - Tumorsize           1 807.28
## - Vascularinvasion    1 813.51
## - Recurrence          1 816.81
## - RFS                 1 835.43
##
## Step:  AIC=804.72
## Surv(OS, Death) ~ Age + HBsAg + AFP + Tumorsize + Tumordifferentiation +
##     Vascularinvasion + RFS + Recurrence
##
##                        Df    AIC
## <none>                    804.72
## + CXCL17P             1 804.95
## - HBsAg               1 805.46
## + BCLC                1 805.60
## - Tumordifferentiation 1 805.66
## + Capsulation         1 805.95
## + Tumormultiplicity   1 806.00
## + Cirrhosis           1 806.08
## - AFP                 1 806.18
## + ALT                 1 806.42
## + CXCL17N             1 806.45
## + AST                 1 806.57
## + TNM                 1 806.62
## + CXCL17T             1 806.68
## - Tumorsize           1 806.93
## - Vascularinvasion    1 814.13
## - Recurrence          1 817.44
## - RFS                 1 835.80
```

Without RFS Included

```
modelAll1n.coxph <- coxph(Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + ALT +AST + AF
P+ Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormultiplicity + Capsul
ation + TNM + BCLC + Recurrence + CXCL17T +  CXCL17P + CXCL17N)

## Warning in coxph.fit(X, Y, istrat, offset, init, control, weights = weights, :
## Loglik converged before variable 14 ; coefficient may be infinite.

result.step1n <-suppressWarnings(step(modelAll1n.coxph, scope=list(upper=~  Age + H
BsAg + Cirrhosis + ALT +AST + AFP+ Tumorsize + Tumordifferentiation + Vascularinvas
ion + Tumormultiplicity + Capsulation + TNM + BCLC + Recurrence + CXCL17T +  CXCL17
P + CXCL17N, lower=~Age)))

## Start:  AIC=841.35
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AST + AFP +
##     Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
```

```
##      Capsulation + TNM + BCLC + Recurrence + CXCL17T + CXCL17P +
##      CXCL17N
##
##                          Df    AIC
## - AST                     1 839.39
## - CXCL17N                  1 839.41
## - ALT                      1 839.47
## - CXCL17T                  1 839.52
## - Cirrhosis                1 839.62
## - TNM                      1 839.88
## - Tumormultiplicity        1 839.92
## - BCLC                     1 840.21
## - CXCL17P                  1 840.52
## - Tumorsize                1 840.74
## - HBsAg                    1 840.77
## - AFP                      1 840.87
## <none>                       841.35
## - Capsulation              1 841.57
## - Vascularinvasion         1 843.68
## - Tumordifferentiation     1 846.16
## - Recurrence               1 952.96
##
## Step:  AIC=839.39
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AFP + Tumorsize +
##      Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##      Capsulation + TNM + BCLC + Recurrence + CXCL17T + CXCL17P +
##      CXCL17N
##
##                          Df    AIC
## - CXCL17N                  1 837.47
## - ALT                      1 837.58
## - CXCL17T                  1 837.59
## - Cirrhosis                1 837.67
## - TNM                      1 837.94
## - Tumormultiplicity        1 837.99
## - BCLC                     1 838.25
## - CXCL17P                  1 838.61
## - Tumorsize                1 838.80
## - HBsAg                    1 838.82
## - AFP                      1 838.96
## <none>                       839.39
## - Capsulation              1 839.83
## + AST                      1 841.35
## - Vascularinvasion         1 841.80
## - Tumordifferentiation     1 844.44
## - Recurrence               1 951.50
##
## Step:  AIC=837.47
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AFP + Tumorsize +
##      Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
```

```
##      Capsulation + TNM + BCLC + Recurrence + CXCL17T + CXCL17P
##
##                          Df    AIC
## - CXCL17T                 1 835.61
## - ALT                     1 835.63
## - Cirrhosis               1 835.74
## - TNM                     1 836.09
## - Tumormultiplicity       1 836.13
## - BCLC                    1 836.27
## - Tumorsize               1 836.82
## - CXCL17P                 1 836.84
## - HBsAg                   1 836.91
## - AFP                     1 836.96
## <none>                      837.47
## - Capsulation             1 837.91
## + CXCL17N                 1 839.39
## + AST                     1 839.41
## - Vascularinvasion        1 840.01
## - Tumordifferentiation    1 842.46
## - Recurrence              1 950.66
##
## Step:  AIC=835.61
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AFP + Tumorsize +
##      Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##      Capsulation + TNM + BCLC + Recurrence + CXCL17P
##
##                          Df    AIC
## - ALT                     1 833.78
## - Cirrhosis               1 833.86
## - TNM                     1 834.31
## - Tumormultiplicity       1 834.31
## - BCLC                    1 834.35
## - Tumorsize               1 834.93
## - AFP                     1 834.97
## - HBsAg                   1 835.25
## <none>                      835.61
## - CXCL17P                 1 835.93
## - Capsulation             1 836.09
## + CXCL17T                 1 837.47
## + AST                     1 837.53
## + CXCL17N                 1 837.59
## - Vascularinvasion        1 838.36
## - Tumordifferentiation    1 840.64
## - Recurrence              1 951.13
##
## Step:  AIC=833.78
## Surv(OS, Death) ~ Age + HBsAg + Cirrhosis + AFP + Tumorsize +
##      Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##      Capsulation + TNM + BCLC + Recurrence + CXCL17P
##
```

```
##                              Df    AIC
## - Cirrhosis                1 832.05
## - Tumormultiplicity        1 832.49
## - TNM                      1 832.58
## - BCLC                     1 832.61
## - Tumorsize                1 832.97
## - AFP                      1 833.21
## - HBsAg                    1 833.41
## <none>                       833.78
## - CXCL17P                  1 834.16
## - Capsulation              1 834.22
## + AST                      1 835.61
## + ALT                      1 835.61
## + CXCL17T                  1 835.63
## + CXCL17N                  1 835.77
## - Vascularinvasion         1 836.36
## - Tumordifferentiation     1 838.76
## - Recurrence               1 949.31
##
## Step:  AIC=832.05
## Surv(OS, Death) ~ Age + HBsAg + AFP + Tumorsize + Tumordifferentiation +
##      Vascularinvasion + Tumormultiplicity + Capsulation + TNM +
##      BCLC + Recurrence + CXCL17P
##
##                              Df    AIC
## - Tumormultiplicity        1 830.70
## - TNM                      1 830.85
## - BCLC                     1 830.92
## - Tumorsize                1 831.10
## - AFP                      1 831.45
## - HBsAg                    1 831.48
## <none>                       832.05
## - Capsulation              1 832.39
## - CXCL17P                  1 832.45
## + Cirrhosis                1 833.78
## + AST                      1 833.85
## + ALT                      1 833.86
## + CXCL17T                  1 833.92
## + CXCL17N                  1 834.04
## - Vascularinvasion         1 834.51
## - Tumordifferentiation     1 837.22
## - Recurrence               1 948.72
##
## Step:  AIC=830.7
## Surv(OS, Death) ~ Age + HBsAg + AFP + Tumorsize + Tumordifferentiation +
##      Vascularinvasion + Capsulation + TNM + BCLC + Recurrence +
##      CXCL17P
##
##                              Df    AIC
## - TNM                      1 829.58
```

```
## - Tumorsize                1 829.74
## - HBsAg                   1 830.07
## <none>                      830.70
## - AFP                     1 830.81
## - CXCL17P                 1 831.14
## - Capsulation             1 831.40
## + Tumormultiplicity       1 832.05
## - BCLC                    1 832.15
## + AST                     1 832.40
## + Cirrhosis               1 832.49
## + ALT                     1 832.51
## - Vascularinvasion        1 832.52
## + CXCL17T                 1 832.53
## + CXCL17N                 1 832.67
## - Tumordifferentiation  1 835.44
## - Recurrence              1 947.37
##
## Step:  AIC=829.58
## Surv(OS, Death) ~ Age + HBsAg + AFP + Tumorsize + Tumordifferentiation +
##      Vascularinvasion + Capsulation + BCLC + Recurrence + CXCL17P
##
##                            Df    AIC
## - HBsAg                   1 828.63
## <none>                      829.58
## - Tumorsize                1 829.66
## - AFP                     1 829.84
## - Capsulation             1 830.23
## + TNM                     1 830.70
## + Tumormultiplicity       1 830.85
## - Vascularinvasion        1 830.90
## - CXCL17P                 1 830.96
## + AST                     1 831.13
## + ALT                     1 831.29
## + CXCL17T                 1 831.32
## + Cirrhosis               1 831.37
## + CXCL17N                 1 831.52
## - BCLC                    1 833.63
## - Tumordifferentiation  1 833.74
## - Recurrence              1 945.73
##
## Step:  AIC=828.63
## Surv(OS, Death) ~ Age + AFP + Tumorsize + Tumordifferentiation +
##      Vascularinvasion + Capsulation + BCLC + Recurrence + CXCL17P
##
##                            Df    AIC
## - Tumorsize                1 828.51
## - AFP                     1 828.57
## <none>                      828.63
## + HBsAg                   1 829.58
## - CXCL17P                 1 829.71
```

```
## + Tumormultiplicity     1 829.98
## + TNM                    1 830.07
## - Capsulation            1 830.10
## + AST                    1 830.19
## + CXCL17T                1 830.19
## - Vascularinvasion       1 830.23
## + ALT                    1 830.39
## + Cirrhosis              1 830.58
## + CXCL17N                1 830.58
## - BCLC                   1 832.53
## - Tumordifferentiation   1 832.56
## - Recurrence             1 943.97
##
## Step:  AIC=828.51
## Surv(OS, Death) ~ Age + AFP + Tumordifferentiation + Vascularinvasion +
##     Capsulation + BCLC + Recurrence + CXCL17P
##
##                          Df    AIC
## <none>                      828.51
## + Tumorsize              1 828.63
## - AFP                    1 828.73
## + TNM                    1 829.10
## - CXCL17P                1 829.57
## - Capsulation            1 829.62
## - Vascularinvasion       1 829.64
## + HBsAg                  1 829.66
## + Tumormultiplicity      1 829.86
## + CXCL17T                1 830.08
## + AST                    1 830.11
## + ALT                    1 830.45
## + CXCL17N                1 830.49
## + Cirrhosis              1 830.51
## - Tumordifferentiation   1 831.95
## - BCLC                   1 833.80
## - Recurrence             1 946.00
```

With RFS Included

```
summary(result.step1)

## Call:
## coxph(formula = Surv(OS, Death) ~ Age + HBsAg + AFP + Tumorsize +
##     Tumordifferentiation + Vascularinvasion + RFS + Recurrence)
##
##   n= 227, number of events= 97
##
##                         coef  exp(coef)  se(coef)       z Pr(>|z|)
## Age                1.220e-02  1.012e+00 8.200e-03   1.488 0.136687
## HBsAg             -7.472e-01  4.737e-01 4.133e-01  -1.808 0.070611 .
## AFP                4.526e-01  1.572e+00 2.513e-01   1.801 0.071724 .
```

```
## Tumorsize               4.432e-01  1.558e+00  2.203e-01   2.011 0.044296 *
## Tumordifferentiation  3.615e-01  1.436e+00  2.097e-01   1.724 0.084642 .
## Vascularinvasion       9.035e-01  2.468e+00  2.504e-01   3.608 0.000309 ***
## RFS                   -6.237e-02  9.395e-01  1.252e-02  -4.981 6.32e-07 ***
## Recurrence            1.804e+01  6.835e+07  2.393e+03   0.008 0.993985
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##                      exp(coef) exp(-coef) lower .95 upper .95
## Age                   1.012e+00  9.879e-01    0.9961    1.0287
## HBsAg                 4.737e-01  2.111e+00    0.2107    1.0648
## AFP                   1.572e+00  6.360e-01    0.9608    2.5732
## Tumorsize             1.558e+00  6.420e-01    1.0114    2.3990
## Tumordifferentiation 1.436e+00  6.966e-01    0.9518    2.1650
## Vascularinvasion      2.468e+00  4.052e-01    1.5108    4.0322
## RFS                   9.395e-01  1.064e+00    0.9168    0.9629
## Recurrence            6.835e+07  1.463e-08    0.0000       Inf
##
## Concordance= 0.872  (se = 0.014 )
## Likelihood ratio test= 191.6  on 8 df,   p=<2e-16
## Wald test            = 52.85  on 8 df,   p=1e-08
## Score (logrank) test = 143.9  on 8 df,   p=<2e-16
```

Without RFS Included

```
result.step1n

## Call:
## coxph(formula = Surv(OS, Death) ~ Age + AFP + Tumordifferentiation +
##     Vascularinvasion + Capsulation + BCLC + Recurrence + CXCL17P)
##
##                            coef  exp(coef)  se(coef)       z       p
## Age                   3.140e-03  1.003e+00  8.147e-03   0.385 0.69991
## AFP                   3.672e-01  1.444e+00  2.531e-01   1.451 0.14682
## Tumordifferentiation  5.082e-01  1.662e+00  2.161e-01   2.351 0.01870
## Vascularinvasion      5.353e-01  1.708e+00  2.997e-01   1.786 0.07412
## Capsulation          -4.471e-01  6.395e-01  2.468e-01  -1.811 0.07010
## BCLC                  7.099e-01  2.034e+00  2.551e-01   2.783 0.00538
## Recurrence            2.019e+01  5.879e+08  2.454e+03   0.008 0.99344
## CXCL17P               1.185e-03  1.001e+00  6.293e-04   1.882 0.05981
##
## Likelihood ratio test=167.8  on 8 df, p=< 2.2e-16
## n= 227, number of events= 97
```

(b) recurrence-free survival.

With OS Included

```
modelAll2.coxph <- suppressWarnings(coxph(Surv(RFS, Death) ~ Age + HBsAg + Cirrhosi
s + ALT +AST + AFP+ Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormult
```

```
iplicity + Capsulation + TNM + BCLC + OS + Recurrence + CXCL17T +  CXCL17P + CXCL17
N))

result.step2 <-suppressWarnings(step(modelAll2.coxph, scope=list(upper=~ Age + HBsA
g + Cirrhosis + ALT +AST + AFP+ Tumorsize + Tumordifferentiation + Vascularinvasion
+ Tumormultiplicity + Capsulation + TNM + BCLC + OS + Recurrence + CXCL17T +  CXCL1
7P + CXCL17N, lower=~Age)))

## Start:  AIC=691.43
## Surv(RFS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AST + AFP +
##     Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##     Capsulation + TNM + BCLC + OS + Recurrence + CXCL17T + CXCL17P +
##     CXCL17N
##
##                          Df    AIC
## - TNM                     1 689.43
## - Capsulation             1 689.43
## - Tumorsize               1 689.45
## - Vascularinvasion        1 689.48
## - ALT                     1 689.58
## - AST                     1 689.68
## - Cirrhosis               1 689.80
## - AFP                     1 689.92
## - BCLC                    1 689.94
## - Tumormultiplicity       1 690.25
## - CXCL17T                 1 690.28
## - HBsAg                   1 690.63
## - Tumordifferentiation    1 690.65
## - CXCL17P                 1 691.41
## <none>                      691.43
## - CXCL17N                 1 691.60
## - Recurrence              1 773.38
## - OS                      1 785.80
##
## Step:  AIC=689.43
## Surv(RFS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AST + AFP +
##     Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##     Capsulation + BCLC + OS + Recurrence + CXCL17T + CXCL17P +
##     CXCL17N
##
##                          Df    AIC
## - Capsulation             1 687.43
## - Tumorsize               1 687.47
## - Vascularinvasion        1 687.48
## - ALT                     1 687.58
## - AST                     1 687.68
## - Cirrhosis               1 687.80
## - AFP                     1 687.92
## - BCLC                    1 688.08
## - Tumormultiplicity       1 688.25
```

```
## - CXCL17T                1 688.28
## - HBsAg                  1 688.65
## - Tumordifferentiation   1 688.66
## <none>                     689.43
## - CXCL17P                1 689.55
## - CXCL17N                1 689.61
## + TNM                    1 691.43
## - Recurrence             1 773.99
## - OS                     1 786.31
##
## Step:   AIC=687.43
## Surv(RFS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AST + AFP +
##      Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##      BCLC + OS + Recurrence + CXCL17T + CXCL17P + CXCL17N
##
##                           Df    AIC
## - Tumorsize               1 685.48
## - Vascularinvasion        1 685.48
## - ALT                     1 685.58
## - AST                     1 685.68
## - Cirrhosis               1 685.82
## - AFP                     1 685.93
## - BCLC                    1 686.08
## - Tumormultiplicity       1 686.25
## - CXCL17T                 1 686.30
## - Tumordifferentiation    1 686.69
## - HBsAg                   1 686.75
## <none>                      687.43
## - CXCL17P                 1 687.57
## - CXCL17N                 1 687.65
## + Capsulation             1 689.43
## + TNM                     1 689.43
## - Recurrence              1 772.03
## - OS                      1 785.86
##
## Step:   AIC=685.48
## Surv(RFS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AST + AFP +
##      Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##      BCLC + OS + Recurrence + CXCL17T + CXCL17P + CXCL17N
##
##                           Df    AIC
## - Vascularinvasion        1 683.54
## - ALT                     1 683.62
## - AST                     1 683.74
## - Cirrhosis               1 683.83
## - AFP                     1 684.00
## - BCLC                    1 684.09
## - CXCL17T                 1 684.30
## - Tumormultiplicity       1 684.34
## - Tumordifferentiation    1 684.69
```

```
## - HBsAg                      1 684.95
## <none>                         685.48
## - CXCL17P                    1 685.59
## - CXCL17N                    1 685.74
## + Tumorsize                  1 687.43
## + TNM                        1 687.46
## + Capsulation                1 687.47
## - Recurrence                 1 771.09
## - OS                         1 784.43
##
## Step:   AIC=683.54
## Surv(RFS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AST + AFP +
##      Tumordifferentiation + Tumormultiplicity + BCLC + OS + Recurrence +
##      CXCL17T + CXCL17P + CXCL17N
##
##                          Df    AIC
## - ALT                     1 681.68
## - AST                     1 681.81
## - Cirrhosis               1 681.96
## - AFP                     1 682.25
## - Tumormultiplicity       1 682.36
## - CXCL17T                 1 682.47
## - Tumordifferentiation    1 682.70
## - BCLC                    1 682.76
## - HBsAg                   1 683.01
## <none>                      683.54
## - CXCL17P                 1 683.60
## - CXCL17N                 1 683.74
## + Vascularinvasion        1 685.48
## + Tumorsize               1 685.48
## + TNM                     1 685.53
## + Capsulation             1 685.53
## - Recurrence              1 771.17
## - OS                      1 783.67
##
## Step:   AIC=681.68
## Surv(RFS, Death) ~ Age + HBsAg + Cirrhosis + AST + AFP + Tumordifferentiation +
##      Tumormultiplicity + BCLC + OS + Recurrence + CXCL17T + CXCL17P +
##      CXCL17N
##
##                          Df    AIC
## - Cirrhosis               1 680.03
## - AST                     1 680.11
## - AFP                     1 680.37
## - Tumormultiplicity       1 680.55
## - CXCL17T                 1 680.56
## - BCLC                    1 680.79
## - Tumordifferentiation    1 680.83
## - HBsAg                   1 681.13
## <none>                      681.68
```

```
## - CXCL17P                1 681.68
## - CXCL17N                1 681.83
## + ALT                    1 683.54
## + Vascularinvasion       1 683.62
## + Tumorsize              1 683.64
## + Capsulation            1 683.67
## + TNM                    1 683.67
## - Recurrence             1 769.43
## - OS                     1 781.68
##
## Step:  AIC=680.03
## Surv(RFS, Death) ~ Age + HBsAg + AST + AFP + Tumordifferentiation +
##     Tumormultiplicity + BCLC + OS + Recurrence + CXCL17T + CXCL17P +
##     CXCL17N
##
##                         Df    AIC
## - AST                    1 678.43
## - AFP                    1 678.74
## - Tumormultiplicity      1 678.83
## - CXCL17T                1 678.88
## - Tumordifferentiation   1 679.16
## - BCLC                   1 679.26
## - HBsAg                  1 679.58
## - CXCL17P                1 679.73
## - CXCL17N                1 680.03
## <none>                     680.03
## + Cirrhosis              1 681.68
## + Vascularinvasion       1 681.90
## + ALT                    1 681.96
## + Capsulation            1 682.01
## + Tumorsize              1 682.03
## + TNM                    1 682.03
## - Recurrence             1 767.93
## - OS                     1 780.07
##
## Step:  AIC=678.43
## Surv(RFS, Death) ~ Age + HBsAg + AFP + Tumordifferentiation +
##     Tumormultiplicity + BCLC + OS + Recurrence + CXCL17T + CXCL17P +
##     CXCL17N
##
##                         Df    AIC
## - Tumormultiplicity      1 677.05
## - CXCL17T                1 677.09
## - AFP                    1 677.18
## - Tumordifferentiation   1 677.57
## - CXCL17P                1 677.82
## - HBsAg                  1 677.94
## - CXCL17N                1 678.27
## <none>                     678.43
## - BCLC                   1 678.53
```

```
## + AST                      1 680.03
## + Cirrhosis                 1 680.11
## + ALT                       1 680.23
## + Vascularinvasion          1 680.28
## + Tumorsize                 1 680.42
## + Capsulation               1 680.42
## + TNM                       1 680.42
## - Recurrence                1 766.15
## - OS                        1 779.46
##
## Step:  AIC=677.05
## Surv(RFS, Death) ~ Age + HBsAg + AFP + Tumordifferentiation +
##     BCLC + OS + Recurrence + CXCL17T + CXCL17P + CXCL17N
##
##                         Df    AIC
## - CXCL17T                1 675.60
## - Tumordifferentiation   1 675.95
## - AFP                    1 676.05
## - CXCL17P                1 676.14
## - HBsAg                  1 676.38
## - CXCL17N                1 676.74
## <none>                     677.05
## + Tumormultiplicity      1 678.43
## + Cirrhosis              1 678.79
## + AST                    1 678.83
## + ALT                    1 678.84
## + Tumorsize              1 679.04
## + Capsulation            1 679.05
## + TNM                    1 679.05
## + Vascularinvasion       1 679.05
## - BCLC                   1 679.47
## - Recurrence             1 764.18
## - OS                     1 779.03
##
## Step:  AIC=675.6
## Surv(RFS, Death) ~ Age + HBsAg + AFP + Tumordifferentiation +
##     BCLC + OS + Recurrence + CXCL17P + CXCL17N
##
##                         Df    AIC
## - CXCL17P                1 674.28
## - Tumordifferentiation   1 674.34
## - AFP                    1 674.38
## - HBsAg                  1 674.80
## - CXCL17N                1 675.34
## <none>                     675.60
## + CXCL17T                1 677.05
## + Tumormultiplicity      1 677.09
## + Cirrhosis              1 677.34
## + ALT                    1 677.48
## + AST                    1 677.50
```

```
## + Vascularinvasion         1 677.58
## + TNM                       1 677.60
## + Capsulation               1 677.60
## + Tumorsize                 1 677.60
## - BCLC                      1 678.24
## - Recurrence                1 762.84
## - OS                        1 779.34
##
## Step:  AIC=674.28
## Surv(RFS, Death) ~ Age + HBsAg + AFP + Tumordifferentiation +
##      BCLC + OS + Recurrence + CXCL17N
##
##                            Df    AIC
## - Tumordifferentiation  1 673.21
## - HBsAg                    1 673.34
## - AFP                      1 673.34
## - CXCL17N                  1 673.34
## <none>                       674.28
## + CXCL17P                  1 675.60
## + Tumormultiplicity        1 675.97
## + CXCL17T                  1 676.14
## + ALT                      1 676.19
## + Cirrhosis                1 676.21
## + TNM                      1 676.23
## + AST                      1 676.25
## + Capsulation              1 676.28
## + Tumorsize                1 676.28
## + Vascularinvasion         1 676.28
## - BCLC                     1 677.85
## - Recurrence               1 761.68
## - OS                       1 778.64
##
## Step:  AIC=673.21
## Surv(RFS, Death) ~ Age + HBsAg + AFP + BCLC + OS + Recurrence +
##      CXCL17N
##
##                            Df    AIC
## - CXCL17N                  1 671.99
## - AFP                      1 672.13
## - HBsAg                    1 672.56
## <none>                       673.21
## + Tumordifferentiation  1 674.28
## + CXCL17P                  1 674.34
## + Tumormultiplicity        1 675.09
## + ALT                      1 675.12
## + TNM                      1 675.14
## + Cirrhosis                1 675.16
## + CXCL17T                  1 675.17
## + AST                      1 675.17
## + Tumorsize                1 675.19
```

```
## + Vascularinvasion       1 675.21
## + Capsulation            1 675.21
## - BCLC                   1 675.86
## - Recurrence             1 759.68
## - OS                     1 782.36
##
## Step:  AIC=671.99
## Surv(RFS, Death) ~ Age + HBsAg + AFP + BCLC + OS + Recurrence
##
##                          Df   AIC
## - AFP                    1 670.93
## - HBsAg                  1 671.40
## <none>                     671.99
## + CXCL17N                1 673.21
## + Tumordifferentiation   1 673.34
## + CXCL17T                1 673.73
## + Tumormultiplicity      1 673.83
## + Cirrhosis              1 673.88
## + ALT                    1 673.93
## + AST                    1 673.94
## + CXCL17P                1 673.97
## + TNM                    1 673.98
## + Tumorsize              1 673.98
## + Capsulation            1 673.99
## + Vascularinvasion       1 673.99
## - BCLC                   1 674.33
## - Recurrence             1 758.80
## - OS                     1 783.07
##
## Step:  AIC=670.93
## Surv(RFS, Death) ~ Age + HBsAg + BCLC + OS + Recurrence
##
##                          Df   AIC
## - HBsAg                  1 670.16
## <none>                     670.93
## + AFP                    1 671.99
## + CXCL17N                1 672.13
## + Tumordifferentiation   1 672.39
## + Tumormultiplicity      1 672.61
## + CXCL17T                1 672.80
## + Cirrhosis              1 672.84
## + AST                    1 672.87
## + ALT                    1 672.88
## + CXCL17P                1 672.88
## + Vascularinvasion       1 672.90
## + TNM                    1 672.92
## + Capsulation            1 672.93
## + Tumorsize              1 672.93
## - BCLC                   1 672.98
## - Recurrence             1 760.49
```

```
## - OS                        1 784.73
##
## Step:  AIC=670.16
## Surv(RFS, Death) ~ Age + BCLC + OS + Recurrence
##
##                             Df    AIC
## <none>                          670.16
## + HBsAg                     1 670.93
## + CXCL17N                   1 671.30
## + Tumordifferentiation      1 671.40
## + AFP                       1 671.40
## - BCLC                      1 671.69
## + Tumormultiplicity         1 671.94
## + Cirrhosis                 1 671.97
## + CXCL17T                   1 672.04
## + AST                       1 672.07
## + Capsulation               1 672.11
## + ALT                       1 672.12
## + Vascularinvasion          1 672.12
## + TNM                       1 672.14
## + CXCL17P                   1 672.14
## + Tumorsize                 1 672.14
## - Recurrence                1 758.53
## - OS                        1 782.89
```

Without OS Included

```
modelAll2n.coxph <- suppressWarnings(coxph(Surv(RFS, Death) ~ Age + HBsAg + Cirrhos
is + ALT +AST + AFP+ Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormul
tiplicity + Capsulation + TNM + BCLC + Recurrence + CXCL17T +  CXCL17P + CXCL17N))

result.step2n <-suppressWarnings(step(modelAll2n.coxph, scope=list(upper=~ Age + HB
sAg + Cirrhosis + ALT +AST + AFP+ Tumorsize + Tumordifferentiation + Vascularinvasi
on + Tumormultiplicity + Capsulation + TNM + BCLC + Recurrence + CXCL17T + CXCL17P
+ CXCL17N, lower=~Age)))

## Start:  AIC=785.8
## Surv(RFS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AST + AFP +
##     Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##     Capsulation + TNM + BCLC + Recurrence + CXCL17T + CXCL17P +
##     CXCL17N
##
##                             Df    AIC
## - CXCL17P                   1 783.80
## - Tumorsize                 1 783.83
## - HBsAg                     1 783.88
## - Cirrhosis                 1 783.88
## - ALT                       1 783.92
## - AST                       1 784.24
```

```
## - CXCL17N                 1 784.39
## - AFP                     1 785.30
## - BCLC                    1 785.30
## - CXCL17T                 1 785.38
## - Capsulation             1 785.56
## - Vascularinvasion        1 785.64
## - Tumormultiplicity       1 785.75
## <none>                      785.80
## - TNM                     1 786.31
## - Tumordifferentiation    1 794.11
## - Recurrence              1 941.17
##
## Step:  AIC=783.8
## Surv(RFS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AST + AFP +
##     Tumorsize + Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##     Capsulation + TNM + BCLC + Recurrence + CXCL17T + CXCL17N
##
##                           Df    AIC
## - Tumorsize               1 781.83
## - HBsAg                   1 781.88
## - Cirrhosis               1 781.88
## - ALT                     1 781.93
## - AST                     1 782.25
## - CXCL17N                 1 782.71
## - AFP                     1 783.32
## - BCLC                    1 783.40
## - Capsulation             1 783.56
## - CXCL17T                 1 783.59
## - Vascularinvasion        1 783.70
## <none>                      783.80
## - Tumormultiplicity       1 783.85
## - TNM                     1 784.47
## + CXCL17P                 1 785.80
## - Tumordifferentiation    1 792.11
## - Recurrence              1 946.79
##
## Step:  AIC=781.83
## Surv(RFS, Death) ~ Age + HBsAg + Cirrhosis + ALT + AST + AFP +
##     Tumordifferentiation + Vascularinvasion + Tumormultiplicity +
##     Capsulation + TNM + BCLC + Recurrence + CXCL17T + CXCL17N
##
##                           Df    AIC
## - HBsAg                   1 779.92
## - Cirrhosis               1 779.93
## - ALT                     1 779.95
## - AST                     1 780.28
## - CXCL17N                 1 780.77
## - AFP                     1 781.39
## - BCLC                    1 781.42
## - Capsulation             1 781.56
```

```
## - CXCL17T                1 781.59
## - Vascularinvasion       1 781.74
## <none>                     781.83
## - Tumormultiplicity       1 781.87
## - TNM                     1 783.32
## + Tumorsize               1 783.80
## + CXCL17P                 1 783.83
## - Tumordifferentiation    1 790.12
## - Recurrence              1 947.82
##
## Step:  AIC=779.92
## Surv(RFS, Death) ~ Age + Cirrhosis + ALT + AST + AFP + Tumordifferentiation +
##     Vascularinvasion + Tumormultiplicity + Capsulation + TNM +
##     BCLC + Recurrence + CXCL17T + CXCL17N
##
##                          Df    AIC
## - Cirrhosis               1 778.01
## - ALT                     1 778.06
## - AST                     1 778.38
## - CXCL17N                 1 778.90
## - AFP                     1 779.47
## - BCLC                    1 779.48
## - Capsulation             1 779.57
## - CXCL17T                 1 779.60
## - Vascularinvasion        1 779.83
## - Tumormultiplicity       1 779.91
## <none>                      779.92
## + HBsAg                   1 781.83
## + Tumorsize               1 781.88
## - TNM                     1 781.89
## + CXCL17P                 1 781.92
## - Tumordifferentiation    1 788.38
## - Recurrence              1 946.27
##
## Step:  AIC=778.01
## Surv(RFS, Death) ~ Age + ALT + AST + AFP + Tumordifferentiation +
##     Vascularinvasion + Tumormultiplicity + Capsulation + TNM +
##     BCLC + Recurrence + CXCL17T + CXCL17N
##
##                          Df    AIC
## - ALT                     1 776.16
## - AST                     1 776.42
## - CXCL17N                 1 776.92
## - AFP                     1 777.61
## - BCLC                    1 777.64
## - CXCL17T                 1 777.73
## - Vascularinvasion        1 777.85
## - Capsulation             1 777.85
## - Tumormultiplicity       1 777.95
## <none>                      778.01
```

```
## + Cirrhosis              1 779.92
## + HBsAg                  1 779.93
## + Tumorsize              1 779.95
## + CXCL17P                1 780.01
## - TNM                    1 780.14
## - Tumordifferentiation   1 786.42
## - Recurrence             1 944.35
##
## Step:  AIC=776.16
## Surv(RFS, Death) ~ Age + AST + AFP + Tumordifferentiation + Vascularinvasion +
##     Tumormultiplicity + Capsulation + TNM + BCLC + Recurrence +
##     CXCL17T + CXCL17N
##
##                          Df    AIC
## - AST                    1 774.87
## - CXCL17N                1 775.21
## - AFP                    1 775.71
## - BCLC                   1 775.72
## - CXCL17T                1 775.81
## - Vascularinvasion       1 775.95
## - Capsulation            1 775.96
## <none>                     776.16
## - Tumormultiplicity      1 776.28
## + ALT                    1 778.01
## + HBsAg                  1 778.06
## + Cirrhosis              1 778.06
## + Tumorsize              1 778.11
## + CXCL17P                1 778.16
## - TNM                    1 778.25
## - Tumordifferentiation   1 784.44
## - Recurrence             1 942.35
##
## Step:  AIC=774.87
## Surv(RFS, Death) ~ Age + AFP + Tumordifferentiation + Vascularinvasion +
##     Tumormultiplicity + Capsulation + TNM + BCLC + Recurrence +
##     CXCL17T + CXCL17N
##
##                          Df    AIC
## - CXCL17N                1 773.77
## - AFP                    1 774.44
## - BCLC                   1 774.49
## - CXCL17T                1 774.65
## - Vascularinvasion       1 774.74
## <none>                     774.87
## - Tumormultiplicity      1 775.05
## - Capsulation            1 775.29
## + AST                    1 776.16
## + ALT                    1 776.42
## + HBsAg                  1 776.74
## + Cirrhosis              1 776.82
```

```
## + Tumorsize                1 776.83
## + CXCL17P                   1 776.85
## - TNM                       1 777.15
## - Tumordifferentiation  1 783.30
## - Recurrence                1 943.67
##
## Step:  AIC=773.77
## Surv(RFS, Death) ~ Age + AFP + Tumordifferentiation + Vascularinvasion +
##      Tumormultiplicity + Capsulation + TNM + BCLC + Recurrence +
##      CXCL17T
##
##                          Df    AIC
## - BCLC                    1 773.26
## - Vascularinvasion        1 773.58
## - AFP                     1 773.64
## <none>                      773.77
## - Tumormultiplicity       1 773.85
## - Capsulation             1 774.21
## + CXCL17N                 1 774.87
## - CXCL17T                 1 775.16
## + ALT                     1 775.18
## + AST                     1 775.21
## + CXCL17P                 1 775.38
## + HBsAg                   1 775.59
## + Tumorsize               1 775.69
## + Cirrhosis               1 775.76
## - TNM                     1 776.26
## - Tumordifferentiation  1 782.08
## - Recurrence              1 945.30
##
## Step:  AIC=773.26
## Surv(RFS, Death) ~ Age + AFP + Tumordifferentiation + Vascularinvasion +
##      Tumormultiplicity + Capsulation + TNM + Recurrence + CXCL17T
##
##                          Df    AIC
## - AFP                     1 772.64
## <none>                      773.26
## + BCLC                    1 773.77
## - CXCL17T                 1 774.08
## - Capsulation             1 774.21
## + CXCL17N                 1 774.49
## + AST                     1 774.65
## + ALT                     1 774.80
## + HBsAg                   1 775.14
## + Tumorsize               1 775.18
## + CXCL17P                 1 775.20
## + Cirrhosis               1 775.23
## - TNM                     1 777.93
## - Tumormultiplicity       1 778.04
## - Vascularinvasion        1 778.31
```

```
## - Tumordifferentiation  1 781.87
## - Recurrence            1 946.01
##
## Step:  AIC=772.64
## Surv(RFS, Death) ~ Age + Tumordifferentiation + Vascularinvasion +
##     Tumormultiplicity + Capsulation + TNM + Recurrence + CXCL17T
##
##                         Df    AIC
## - CXCL17T                1 772.53
## <none>                     772.64
## + AFP                    1 773.26
## - Capsulation            1 773.60
## + CXCL17N                1 773.60
## + BCLC                   1 773.64
## + AST                    1 774.07
## + ALT                    1 774.22
## + Tumorsize              1 774.48
## + HBsAg                  1 774.53
## + CXCL17P                1 774.58
## + Cirrhosis              1 774.60
## - TNM                    1 777.45
## - Vascularinvasion       1 778.95
## - Tumormultiplicity      1 779.29
## - Tumordifferentiation   1 782.19
## - Recurrence             1 953.48
##
## Step:  AIC=772.53
## Surv(RFS, Death) ~ Age + Tumordifferentiation + Vascularinvasion +
##     Tumormultiplicity + Capsulation + TNM + Recurrence
##
##                         Df    AIC
## + CXCL17N                1 772.33
## <none>                     772.53
## + CXCL17T                1 772.64
## - Capsulation            1 773.47
## + CXCL17P                1 773.65
## + BCLC                   1 773.77
## + AST                    1 773.88
## + AFP                    1 774.08
## + ALT                    1 774.16
## + Cirrhosis              1 774.50
## + Tumorsize              1 774.51
## + HBsAg                  1 774.52
## - TNM                    1 777.80
## - Tumormultiplicity      1 778.73
## - Vascularinvasion       1 779.56
## - Tumordifferentiation   1 781.56
## - Recurrence             1 959.33
##
## Step:  AIC=772.33
```

```
## Surv(RFS, Death) ~ Age + Tumordifferentiation + Vascularinvasion +
##     Tumormultiplicity + Capsulation + TNM + Recurrence + CXCL17N
##
##                          Df   AIC
## <none>                       772.33
## - CXCL17N                1 772.53
## - Capsulation            1 773.24
## + BCLC                   1 773.30
## + AST                    1 773.44
## + CXCL17T                1 773.60
## + AFP                    1 773.88
## + ALT                    1 774.08
## + Cirrhosis              1 774.18
## + Tumorsize              1 774.31
## + HBsAg                  1 774.32
## + CXCL17P                1 774.33
## - TNM                    1 776.95
## - Tumormultiplicity      1 779.17
## - Vascularinvasion       1 779.47
## - Tumordifferentiation   1 781.66
## - Recurrence             1 953.67
```

With OS Included

```
summary(result.step2)
```

```
## Call:
## coxph(formula = Surv(RFS, Death) ~ Age + BCLC + OS + Recurrence)
##
##    n= 227, number of events= 97
##
##                  coef  exp(coef)   se(coef)       z Pr(>|z|)
## Age         2.410e-03  1.002e+00  8.389e-03   0.287    0.774
## BCLC        4.237e-01  1.528e+00  2.262e-01   1.873    0.061 .
## OS         -9.582e-02  9.086e-01  1.203e-02  -7.962 1.69e-15 ***
## Recurrence  2.027e+01  6.375e+08  2.400e+03   0.008    0.993
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##            exp(coef) exp(-coef) lower .95 upper .95
## Age        1.002e+00  9.976e-01    0.9861    1.0190
## BCLC       1.528e+00  6.546e-01    0.9806    2.3797
## OS         9.086e-01  1.101e+00    0.8874    0.9303
## Recurrence 6.375e+08  1.569e-09    0.0000       Inf
##
## Concordance= 0.923  (se = 0.011 )
## Likelihood ratio test= 314.5  on 4 df,   p=<2e-16
## Wald test            = 76.38  on 4 df,   p=1e-15
## Score (logrank) test = 239  on 4 df,   p=<2e-16
```

```
### Without OS Included
result.step2n

## Call:
## coxph(formula = Surv(RFS, Death) ~ Age + Tumordifferentiation +
##     Vascularinvasion + Tumormultiplicity + Capsulation + TNM +
##     Recurrence + CXCL17N)
##
##                          coef  exp(coef)   se(coef)       z         p
## Age                 -1.082e-02  9.892e-01  8.320e-03  -1.301  0.193380
## Tumordifferentiation 7.655e-01  2.150e+00  2.261e-01   3.385  0.000711
## Vascularinvasion     7.959e-01  2.216e+00  2.481e-01   3.208  0.001338
## Tumormultiplicity    7.570e-01  2.132e+00  2.498e-01   3.030  0.002446
## Capsulation         -4.383e-01  6.451e-01  2.508e-01  -1.748  0.080533
## TNM                  6.127e-01  1.845e+00  2.385e-01   2.568  0.010216
## Recurrence           2.147e+01  2.109e+09  2.392e+03   0.009  0.992838
## CXCL17N              7.706e-04  1.001e+00  4.861e-04   1.585  0.112888
##
## Likelihood ratio test=220.3  on 8 df, p=< 2.2e-16
## n= 227, number of events= 97



#####
## 7.1. Consider the case deletion and dfbeta residuals discussed in Sect. 7.1.2. F
or each of the covariates in the final pharmacoSmoking model (grp, employment level
s 2 and 3 vs. 1, and age), plot the case deletion residuals versus the dfbeta resid
uals. Also plot the "dfbeta" residuals versus the "dfbetas" residuals. Do you see a
ny differences?
#####
library(survival)
library(asaur)
library(MASS)
library(survminer)               # Load the package

## Warning: package 'survminer' was built under R version 4.2.3

## Loading required package: ggplot2

## Loading required package: ggpubr

##
## Attaching package: 'survminer'

## The following object is masked from 'package:survival':
##
##     myeloma

library(ggfortify)
attach(pharmacoSmoking)
```

```
library(ggplot2)
head(pharmacoSmoking)

##      id ttr relapse           grp age gender       race employment yearsSmoking
## 1   21 182       0    patchOnly  36   Male      white         ft           26
## 2  113  14       1    patchOnly  41   Male      white      other           27
## 3   39   5       1  combination  25 Female      white      other           12
## 4   80  16       1  combination  54   Male      white         ft           39
## 5   87   0       1  combination  45   Male      white      other           30
## 6   29 182       0  combination  43   Male  hispanic         ft           30
##   levelSmoking ageGroup2 ageGroup4 priorAttempts longestNoSmoke
## 1        heavy     21-49     35-49             0              0
## 2        heavy     21-49     35-49             3             90
## 3        heavy     21-49     21-34             3             21
## 4        heavy       50+     50-64             0              0
## 5        heavy     21-49     35-49             0              0
## 6        heavy     21-49     35-49             2           1825

result.coxph <- coxph(Surv(ttr, relapse) ~ grp + employment
+ age)
result.coxph

## Call:
## coxph(formula = Surv(ttr, relapse) ~ grp + employment + age)
##
##                     coef exp(coef) se(coef)      z       p
## grppatchOnly     0.60788   1.83654  0.21837  2.784 0.00537
## employmentother  0.70348   2.02077  0.26929  2.612 0.00899
## employmentpt     0.65369   1.92262  0.32732  1.997 0.04581
## age             -0.03529   0.96533  0.01075 -3.282 0.00103
##
## Likelihood ratio test=22.03  on 4 df, p=0.0001979
## n= 125, number of events= 89

coef.all_1 <- result.coxph$coef[1]
coef.all_1

## grppatchOnly
##     0.607884

n.obs1 <- length(ttr)
jkbeta.vec1 <- rep(NA, n.obs1)
for (i in 1:n.obs1) {
tt.i <- ttr[-i]
delta.i <- relapse[-i]
grp.i <- grp[-i]
employment.i <- employment[-i]
age.i <- age[-i]
result.coxph.i <- coxph(Surv(tt.i, delta.i) ~ grp.i +
employment.i + age.i)
coef.i <- result.coxph.i$coef[1]
```

```
jkbeta.vec1[i] <- (coef.all_1 - coef.i)
}

index.obs1 <- 1:n.obs1
plot(jkbeta.vec1 ~ index.obs1, type="h",main="Residuals versus the patient ID's",
xlab="Observation", ylab="Change in coefficient for grppatchOnly")
abline(h=0)

identify(jkbeta.vec1 ~ index.obs1)
```


Residuals versus the patient ID's
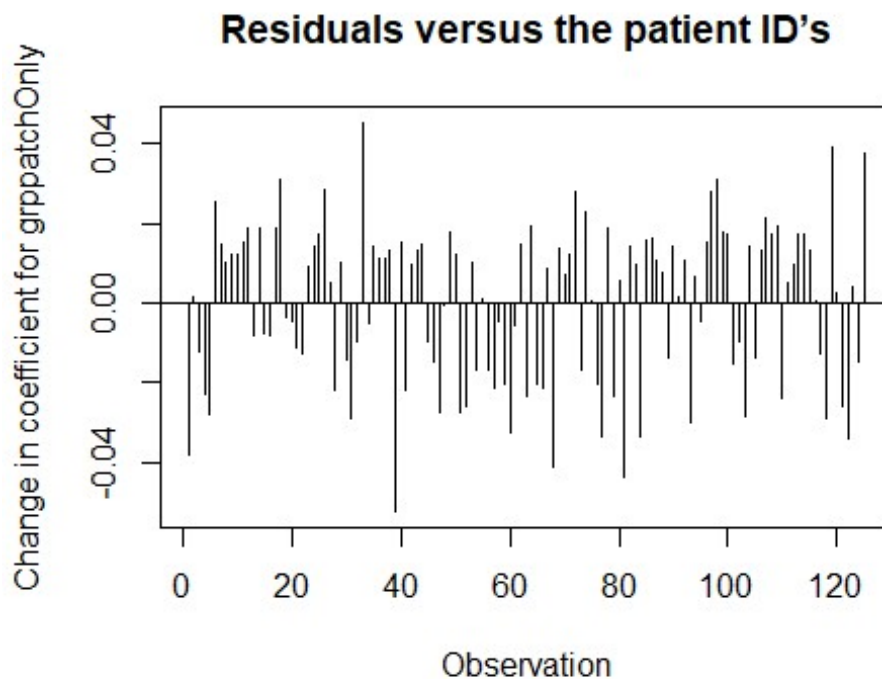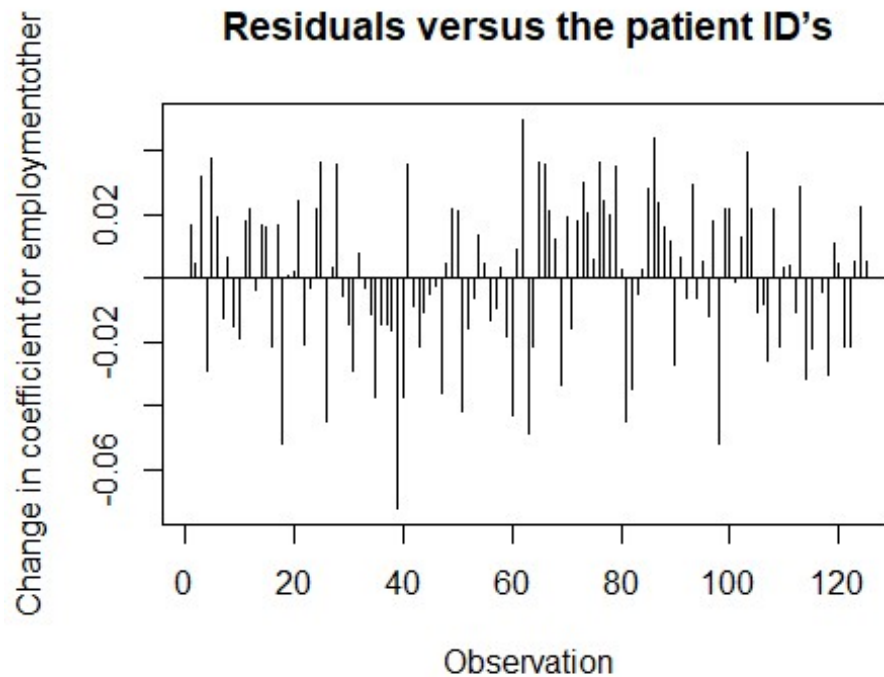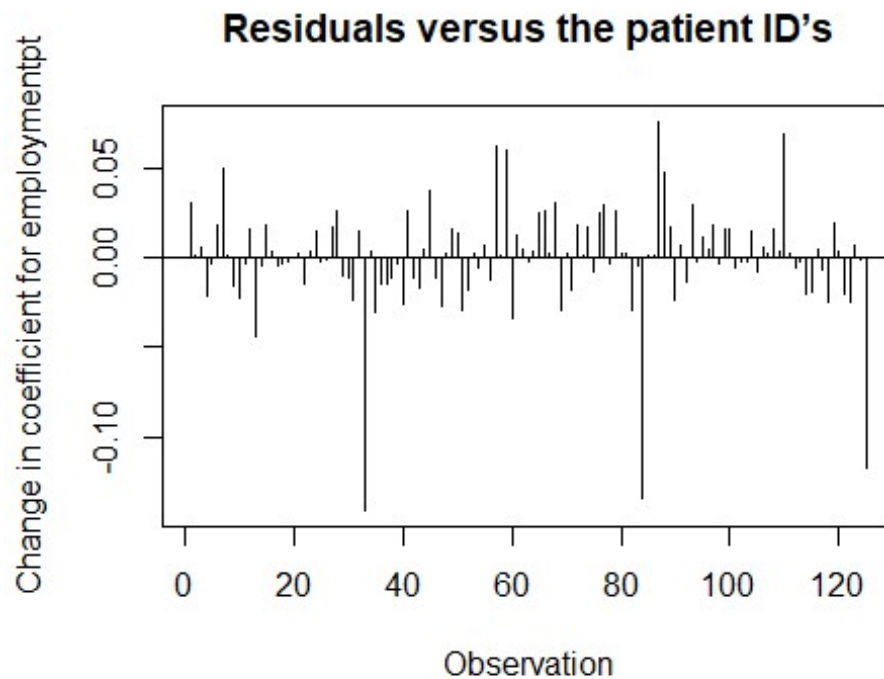
```
## integer(0)

resid.dfbeta1 <- residuals(result.coxph, type="dfbeta")
n.obs <- length(ttr)
index.obs1 <- 1:n.obs1
plot(resid.dfbeta1[,1] ~ index.obs1, type="h", main= "dfbeta Residuals",
xlab="Observation", ylab="Change in coefficient for grppatchOnly")
abline(h=0)
identify(resid.dfbeta1[,1] ~ index.obs1)
```

dfbeta Residuals
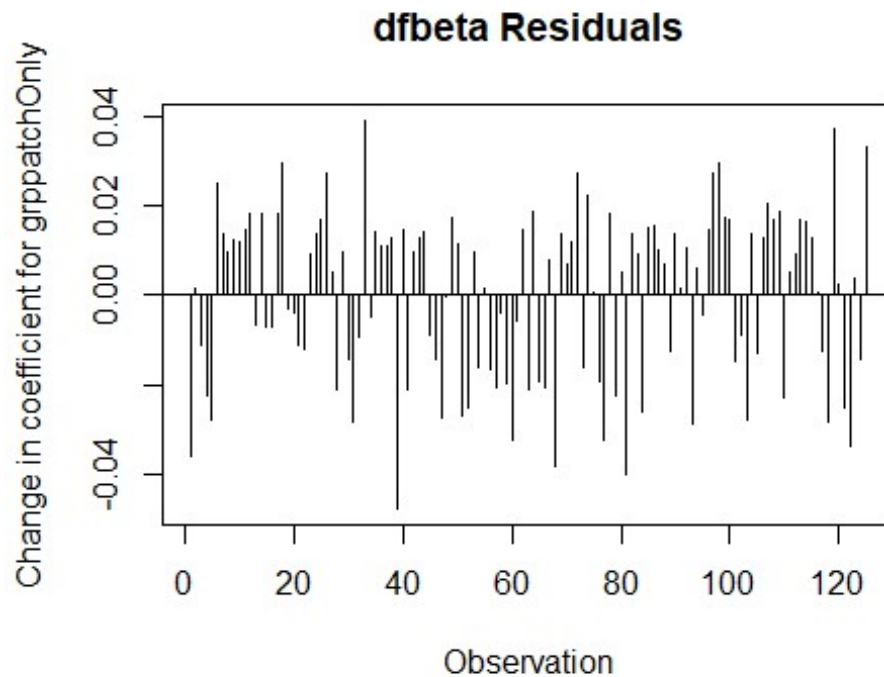
```
## integer(0)

coef.all_2 <- result.coxph$coef[2]
coef.all_2

## employmentother
##      0.7034766

n.obs2 <- length(ttr)
jkbeta.vec2 <- rep(NA, n.obs2)
for (i in 1:n.obs2) {
tt.i <- ttr[-i]
delta.i <- relapse[-i]
grp.i <- grp[-i]
employment.i <- employment[-i]
age.i <- age[-i]
result.coxph.i <- coxph(Surv(tt.i, delta.i) ~ grp.i +
employment.i + age.i)
coef.i <- result.coxph.i$coef[2]
jkbeta.vec2[i] <- (coef.all_2 - coef.i)
}

index.obs2 <- 1:n.obs2
plot(jkbeta.vec2 ~ index.obs2, type="h",
xlab="Observation", ylab="Change in coefficient for employmentother",
main="Residuals versus the patient ID's")
abline(h=0)
```

```
identify(jkbeta.vec2 ~ index.obs2)
```

Residuals versus the patient ID's


```
## integer(0)

resid.dfbeta2 <- residuals(result.coxph, type="dfbeta")
n.obs <- length(ttr)
index.obs2 <- 1:n.obs2
plot(resid.dfbeta2[,2] ~ index.obs2, type="h", main= "dfbeta Residuals",
xlab="Observation", ylab="Change in coefficient for employmentother")
abline(h=0)
identify(resid.dfbeta2[,2] ~ index.obs2)
```
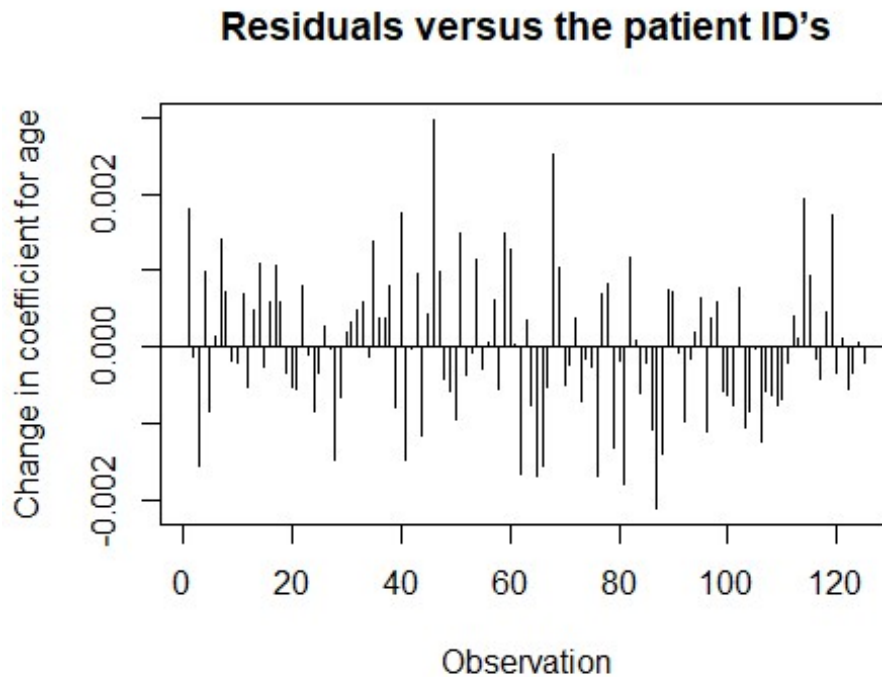
dfbeta Residuals
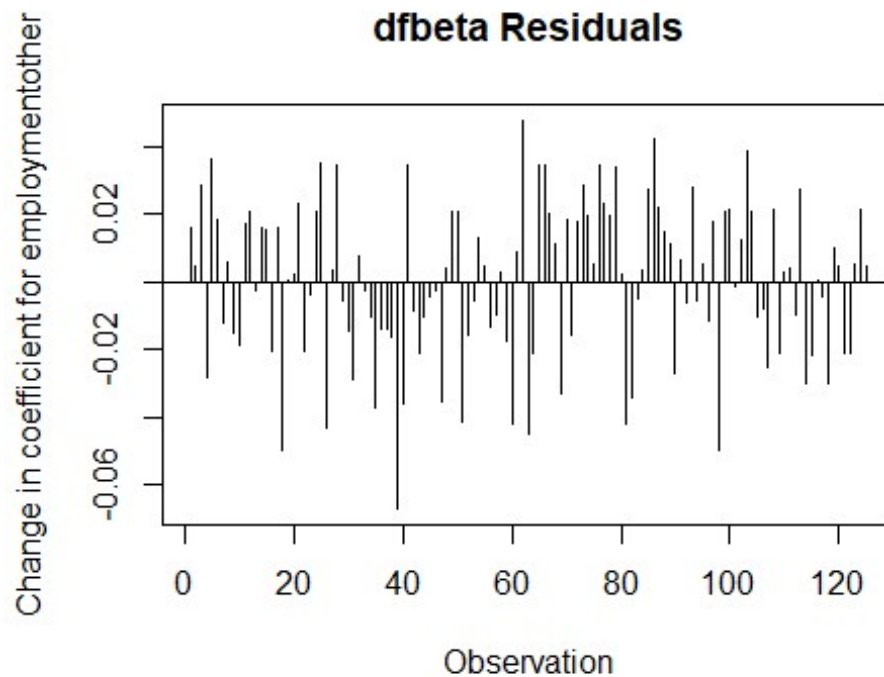

```
## integer(0)

coef.all_3 <- result.coxph$coef[3]
coef.all_3

## employmentpt
##    0.6536902

n.obs3 <- length(ttr)
jkbeta.vec3 <- rep(NA, n.obs3)
for (i in 1:n.obs3) {
tt.i <- ttr[-i]
delta.i <- relapse[-i]
grp.i <- grp[-i]
employment.i <- employment[-i]
age.i <- age[-i]
result.coxph.i <- coxph(Surv(tt.i, delta.i) ~ grp.i +
employment.i + age.i)
coef.i <- result.coxph.i$coef[3]
jkbeta.vec3[i] <- (coef.all_3 - coef.i)
}

index.obs3 <- 1:n.obs3
plot(jkbeta.vec3 ~ index.obs3, type="h",
xlab="Observation", ylab="Change in coefficient for employmentpt",
main="Residuals versus the patient ID's")
abline(h=0)
```

```
identify(jkbeta.vec3 ~ index.obs3)
```

Residuals versus the patient ID's


```
## integer(0)

resid.dfbeta3 <- residuals(result.coxph, type="dfbeta")
n.obs <- length(ttr)
index.obs3 <- 1:n.obs3
plot(resid.dfbeta3[,3] ~ index.obs3, type="h", main= "dfbeta Residuals",
xlab="Observation", ylab="Change in coefficient for employmentpt")
abline(h=0)
identify(resid.dfbeta3[,3] ~ index.obs3)
```
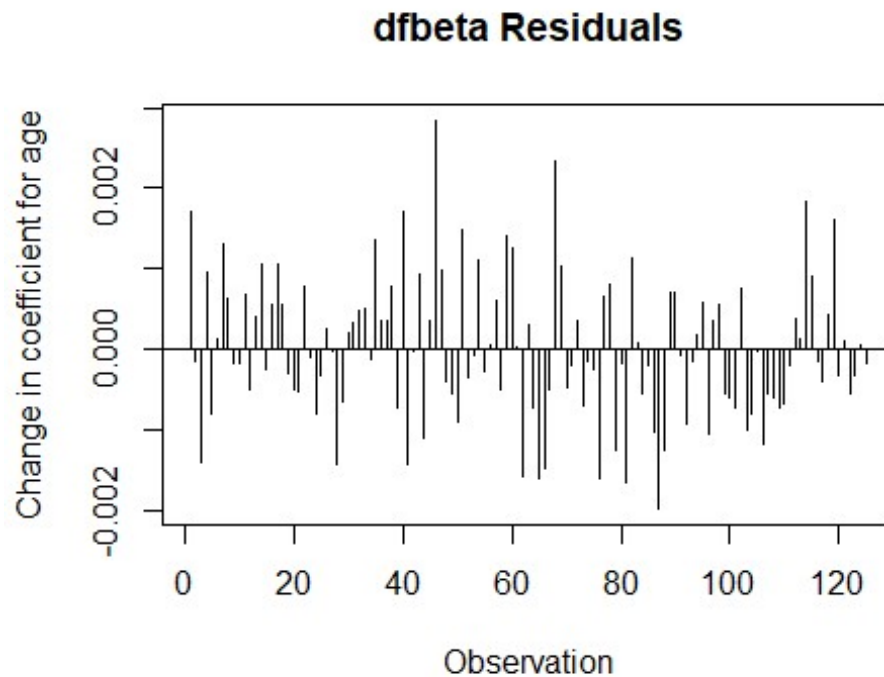
dfbeta Residuals
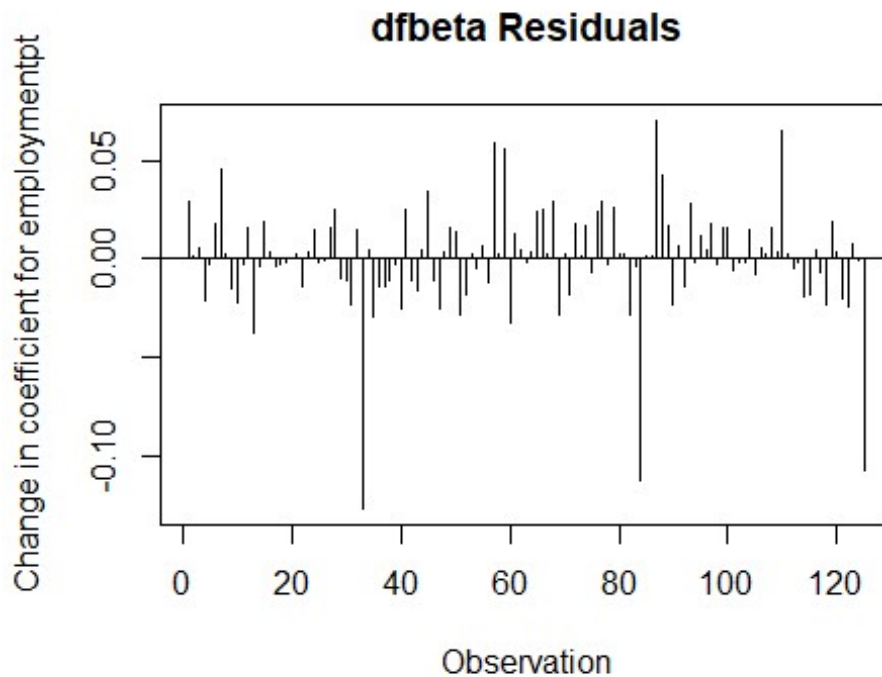

```
## integer(0)

coef.all_4 <- result.coxph$coef[4]
coef.all_4

##            age
## -0.03528934

n.obs4 <- length(ttr)
jkbeta.vec4 <- rep(NA, n.obs4)
for (i in 1:n.obs4) {
tt.i <- ttr[-i]
delta.i <- relapse[-i]
grp.i <- grp[-i]
employment.i <- employment[-i]
age.i <- age[-i]
result.coxph.i <- coxph(Surv(tt.i, delta.i) ~ grp.i +
employment.i + age.i)
coef.i <- result.coxph.i$coef[4]
jkbeta.vec4[i] <- (coef.all_4 - coef.i)
}

index.obs4 <- 1:n.obs4
plot(jkbeta.vec4 ~ index.obs4, type="h",main="Residuals versus the patient ID's",
xlab="Observation", ylab="Change in coefficient for age"
)
abline(h=0)
```

```
identify(jkbeta.vec4 ~ index.obs4)
```

## Residuals versus the patient ID's


```
## integer(0)

resid.dfbeta4 <- residuals(result.coxph, type="dfbeta")
n.obs <- length(ttr)
index.obs4 <- 1:n.obs4
head(resid.dfbeta4)

##              [,1]         [,2]         [,3]          [,4]
## 1 -0.035992243  0.016039067  0.029442996  0.0017000609
## 2  0.001489819  0.004893592  0.001746782 -0.0001361549
## 3 -0.011033222  0.028769501  0.005825861 -0.0014034177
## 4 -0.022264005 -0.028321158 -0.021135909  0.0009633467
## 5 -0.027593571  0.036400215 -0.002712807 -0.0007943478
## 6  0.025089714  0.018742984  0.017774738  0.0001408364

plot(resid.dfbeta4[,4] ~ index.obs4, type="h", main= "dfbeta Residuals",
xlab="Observation", ylab="Change in coefficient for age")
abline(h=0)
identify(resid.dfbeta4[,4] ~ index.obs4)
```

dfbeta Residuals


```
## integer(0)

resid.dfbeta <- residuals(result.coxph, type="dfbetas")
n.obs <- length(ttr)
index.obs <- 1:n.obs
head(resid.dfbeta)

##              [,1]         [,2]          [,3]          [,4]
## 1 -0.164823287   0.05955969   0.089952431   0.15809557
## 2  0.006822493   0.01817193   0.005336660  -0.01266160
## 3 -0.050525661   0.10683305   0.017798812  -0.13050951
## 4 -0.101956037  -0.10516817  -0.064573127   0.08958552
## 5 -0.126362316   0.13516905  -0.008288001  -0.07386963
## 6  0.114896122   0.06960045   0.054304287   0.01309695

plot(resid.dfbeta[,1] ~ index.obs, type="h", main= "Refined dfbeta Residuals",
xlab="Observation", ylab="Standardized change in coefficient for grppatchOnly")
abline(h=0)
```
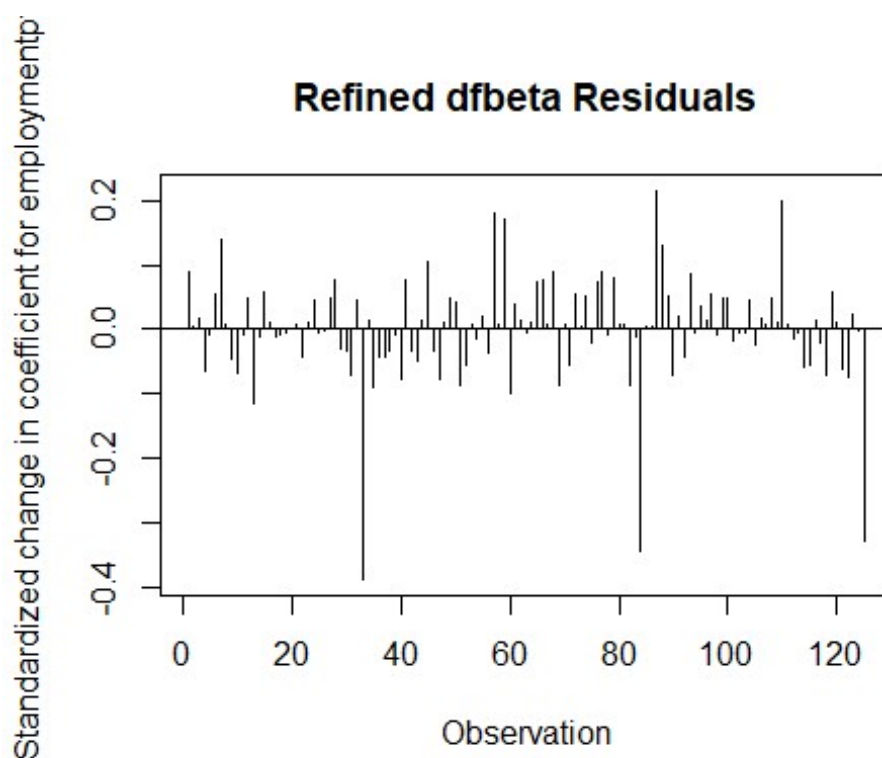
Refined dfbeta Residuals

Standardized change in coefficient for grppatchOnly
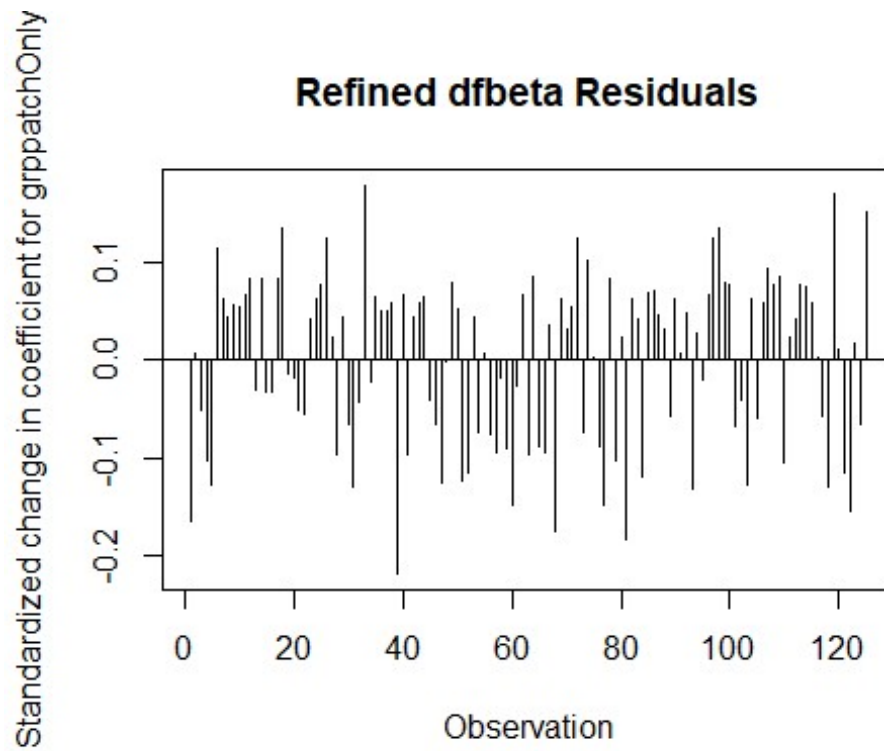
Observation

```
plot(resid.dfbeta[,2] ~ index.obs, type="h", main= "Refined dfbeta Residuals",
xlab="Observation", ylab="Standardized change in coefficient for employmentother")
abline(h=0)
```

Refined dfbeta Residuals

Standardized change in coefficient for employmentoth
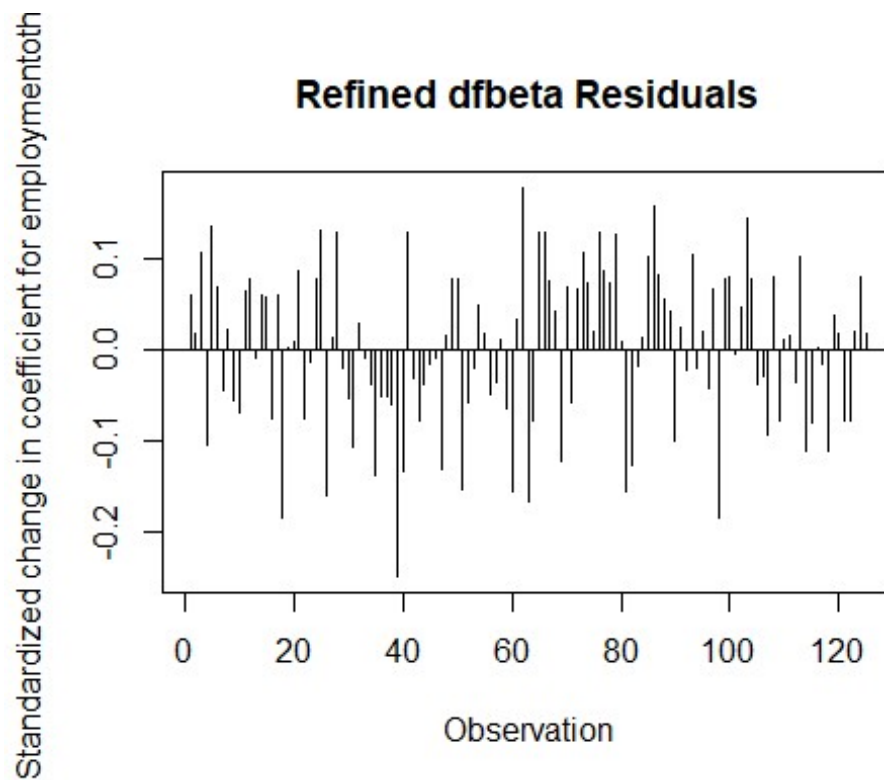
Observation

```r
plot(resid.dfbeta[,3] ~ index.obs, type="h", main= "Refined dfbeta Residuals",
xlab="Observation", ylab="Standardized change in coefficient for employmentpt")
abline(h=0)
```


Refined dfbeta Residuals

```r
plot(resid.dfbeta[,4] ~ index.obs, type="h", main= "Refined dfbeta Residuals",
xlab="Observation", ylab="Standardized change in coefficient for age ")
abline(h=0)
```

Refined dfbeta Residuals
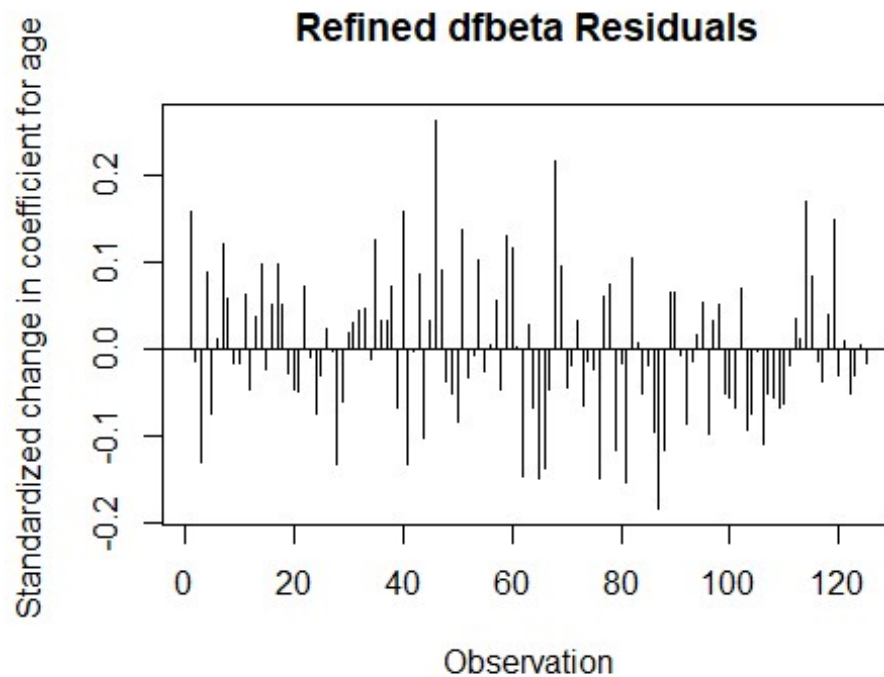
The dfbeta residuals plots (not shown) are nearly identical to those plots of residuals versus the patient id's.

The refined dfbeta residuals scale the dfbeta residuals by an estimate of their standard error, making it easier to compare the magnitudes of the dfbeta residuals for different predictor variables.