Survaivl Analysis

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```
dataset <- read.csv("C:\\Users\\s137614\\Downloads\\archive\\veterans_lung_cancer_clinical_trial.csv.cs
dataset
```

```
##      ID TIME Y      trt  celltype karno diagtime age priortherapy
## 1    1    0 0 standard  squamous    60        7  69           no
## 2    1   72 1 standard  squamous    60        7  69           no
## 3    2    0 0 standard  squamous    70        5  64          yes
## 4    2  411 1 standard  squamous    70        5  64          yes
## 5    3    0 0 standard  squamous    60        3  38           no
## 6    3  228 1 standard  squamous    60        3  38           no
## 7    4    0 0 standard  squamous    60        9  63          yes
## 8    4  126 1 standard  squamous    60        9  63          yes
## 9    5    0 0 standard  squamous    70       11  65          yes
## 10   5  118 1 standard  squamous    70       11  65          yes
## 11   6    0 0 standard  squamous    20        5  49           no
## 12   6   10 1 standard  squamous    20        5  49           no
## 13   7    0 0 standard  squamous    40       10  69          yes
## 14   7   82 1 standard  squamous    40       10  69          yes
## 15   8    0 0 standard  squamous    80       29  68           no
## 16   8  110 1 standard  squamous    80       29  68           no
## 17   9    0 0 standard  squamous    50       18  43           no
## 18   9  314 1 standard  squamous    50       18  43           no
## 19  10    0 0 standard  squamous    70        6  70           no
## 20  10  100 0 standard  squamous    70        6  70           no
## 21  11    0 0 standard  squamous    60        4  81           no
## 22  11   42 1 standard  squamous    60        4  81           no
## 23  12    0 0 standard  squamous    40       58  63          yes
## 24  12    8 1 standard  squamous    40       58  63          yes
## 25  13    0 0 standard  squamous    30        4  63           no
## 26  13  144 1 standard  squamous    30        4  63           no
## 27  14    0 0 standard  squamous    80        9  52          yes
## 28  14   25 0 standard  squamous    80        9  52          yes
## 29  15    0 0 standard  squamous    70       11  48          yes
## 30  15   11 1 standard  squamous    70       11  48          yes
## 31  16    0 0 standard smallcell    60        3  61           no
## 32  16   30 1 standard smallcell    60        3  61           no
## 33  17    0 0 standard smallcell    60        9  42           no
## 34  17  384 1 standard smallcell    60        9  42           no
## 35  18    0 0 standard smallcell    40        2  35           no
## 36  18    4 1 standard smallcell    40        2  35           no
## 37  19    0 0 standard smallcell    80        4  63          yes
## 38  19   54 1 standard smallcell    80        4  63          yes
## 39  20    0 0 standard smallcell    60        4  56           no
```

```
## 40   20    13 1 standard smallcell    60       4  56          no
## 41   21     0 0 standard smallcell    40       3  55          no
## 42   21   123 0 standard smallcell    40       3  55          no
## 43   22     0 0 standard smallcell    60       5  67          no
## 44   22    97 0 standard smallcell    60       5  67          no
## 45   23     0 0 standard smallcell    60      14  63         yes
## 46   23   153 1 standard smallcell    60      14  63         yes
## 47   24     0 0 standard smallcell    30       2  65          no
## 48   24    59 1 standard smallcell    30       2  65          no
## 49   25     0 0 standard smallcell    80       3  46          no
## 50   25   117 1 standard smallcell    80       3  46          no
## 51   26     0 0 standard smallcell    30       4  53         yes
## 52   26    16 1 standard smallcell    30       4  53         yes
## 53   27     0 0 standard smallcell    50      12  69          no
## 54   27   151 1 standard smallcell    50      12  69          no
## 55   28     0 0 standard smallcell    60       4  68          no
## 56   28    22 1 standard smallcell    60       4  68          no
## 57   29     0 0 standard smallcell    80      12  43         yes
## 58   29    56 1 standard smallcell    80      12  43         yes
## 59   30     0 0 standard smallcell    40       2  55         yes
## 60   30    21 1 standard smallcell    40       2  55         yes
## 61   31     0 0 standard smallcell    20      15  42          no
## 62   31    18 1 standard smallcell    20      15  42          no
## 63   32     0 0 standard smallcell    80       2  64          no
## 64   32   139 1 standard smallcell    80       2  64          no
## 65   33     0 0 standard smallcell    30       5  65          no
## 66   33    20 1 standard smallcell    30       5  65          no
## 67   34     0 0 standard smallcell    75       3  65          no
## 68   34    31 1 standard smallcell    75       3  65          no
## 69   35     0 0 standard smallcell    70       2  55          no
## 70   35    52 1 standard smallcell    70       2  55          no
## 71   36     0 0 standard smallcell    60      25  66         yes
## 72   36   287 1 standard smallcell    60      25  66         yes
## 73   37     0 0 standard smallcell    30       4  60          no
## 74   37    18 1 standard smallcell    30       4  60          no
## 75   38     0 0 standard smallcell    60       1  67          no
## 76   38    51 1 standard smallcell    60       1  67          no
## 77   39     0 0 standard smallcell    80      28  53          no
## 78   39   122 1 standard smallcell    80      28  53          no
## 79   40     0 0 standard smallcell    60       8  62          no
## 80   40    27 1 standard smallcell    60       8  62          no
## 81   41     0 0 standard smallcell    70       1  67          no
## 82   41    54 1 standard smallcell    70       1  67          no
## 83   42     0 0 standard smallcell    50       7  72          no
## 84   42     7 1 standard smallcell    50       7  72          no
## 85   43     0 0 standard smallcell    50      11  48          no
## 86   43    63 1 standard smallcell    50      11  48          no
## 87   44     0 0 standard smallcell    40       4  68          no
## 88   44   392 1 standard smallcell    40       4  68          no
## 89   45     0 0 standard smallcell    40      23  67         yes
## 90   45    10 1 standard smallcell    40      23  67         yes
## 91   46     0 0 standard    adeno    20      19  61         yes
## 92   46     8 1 standard    adeno    20      19  61         yes
## 93   47     0 0 standard    adeno    70      10  60          no
```

```
## 94   47   92 1 standard    adeno    70   10 60       no
## 95   48    0 0 standard    adeno    40    6 62       no
## 96   48   35 1 standard    adeno    40    6 62       no
## 97   49    0 0 standard    adeno    80    2 38       no
## 98   49  117 1 standard    adeno    80    2 38       no
## 99   50    0 0 standard    adeno    80    5 50       no
## 100  50  132 1 standard    adeno    80    5 50       no
## 101  51    0 0 standard    adeno    50    4 63      yes
## 102  51   12 1 standard    adeno    50    4 63      yes
## 103  52    0 0 standard    adeno    80    5 64       no
## 104  52  162 1 standard    adeno    80    5 64       no
## 105  53    0 0 standard    adeno    30    3 43       no
## 106  53    3 1 standard    adeno    30    3 43       no
## 107  54    0 0 standard    adeno    80    4 34       no
## 108  54   95 1 standard    adeno    80    4 34       no
## 109  55    0 0 standard    large    50   16 66      yes
## 110  55  177 1 standard    large    50   16 66      yes
## 111  56    0 0 standard    large    80    5 62       no
## 112  56  162 1 standard    large    80    5 62       no
## 113  57    0 0 standard    large    50   15 52       no
## 114  57  216 1 standard    large    50   15 52       no
## 115  58    0 0 standard    large    70    2 47       no
## 116  58  553 1 standard    large    70    2 47       no
## 117  59    0 0 standard    large    60   12 63       no
## 118  59  278 1 standard    large    60   12 63       no
## 119  60    0 0 standard    large    40   12 68      yes
## 120  60   12 1 standard    large    40   12 68      yes
## 121  61    0 0 standard    large    80    5 45       no
## 122  61  260 1 standard    large    80    5 45       no
## 123  62    0 0 standard    large    80   12 41      yes
## 124  62  200 1 standard    large    80   12 41      yes
## 125  63    0 0 standard    large    70    2 66       no
## 126  63  156 1 standard    large    70    2 66       no
## 127  64    0 0 standard    large    90    2 62       no
## 128  64  182 0 standard    large    90    2 62       no
## 129  65    0 0 standard    large    90    8 60       no
## 130  65  143 1 standard    large    90    8 60       no
## 131  66    0 0 standard    large    80   11 66       no
## 132  66  105 1 standard    large    80   11 66       no
## 133  67    0 0 standard    large    80    5 38       no
## 134  67  103 1 standard    large    80    5 38       no
## 135  68    0 0 standard    large    70    8 53      yes
## 136  68  250 1 standard    large    70    8 53      yes
## 137  69    0 0 standard    large    60   13 37      yes
## 138  69  100 1 standard    large    60   13 37      yes
## 139  70    0 0     test squamous    90   12 54      yes
## 140  70  999 1     test squamous    90   12 54      yes
## 141  71    0 0     test squamous    80    6 60       no
## 142  71  112 1     test squamous    80    6 60       no
## 143  72    0 0     test squamous    80    3 48       no
## 144  72   87 0     test squamous    80    3 48       no
## 145  73    0 0     test squamous    50    8 52      yes
## 146  73  231 0     test squamous    50    8 52      yes
## 147  74    0 0     test squamous    50    1 70       no
```

```
## 148  74 242 1    test  squamous   50     1 70        no
## 149  75   0 0    test  squamous   70     7 50       yes
## 150  75 991 1    test  squamous   70     7 50       yes
## 151  76   0 0    test  squamous   70     3 62        no
## 152  76 111 1    test  squamous   70     3 62        no
## 153  77   0 0    test  squamous   20    21 65       yes
## 154  77   1 1    test  squamous   20    21 65       yes
## 155  78   0 0    test  squamous   60     3 58        no
## 156  78 587 1    test  squamous   60     3 58        no
## 157  79   0 0    test  squamous   90     2 62        no
## 158  79 389 1    test  squamous   90     2 62        no
## 159  80   0 0    test  squamous   30     6 64        no
## 160  80  33 1    test  squamous   30     6 64        no
## 161  81   0 0    test  squamous   20    36 63        no
## 162  81  25 1    test  squamous   20    36 63        no
## 163  82   0 0    test  squamous   70    13 58        no
## 164  82 357 1    test  squamous   70    13 58        no
## 165  83   0 0    test  squamous   90     2 64        no
## 166  83 467 1    test  squamous   90     2 64        no
## 167  84   0 0    test  squamous   80    28 52       yes
## 168  84 201 1    test  squamous   80    28 52       yes
## 169  85   0 0    test  squamous   50     7 35        no
## 170  85   1 1    test  squamous   50     7 35        no
## 171  86   0 0    test  squamous   70    11 63        no
## 172  86  30 1    test  squamous   70    11 63        no
## 173  87   0 0    test  squamous   60    13 70       yes
## 174  87  44 1    test  squamous   60    13 70       yes
## 175  88   0 0    test  squamous   90     2 51        no
## 176  88 283 1    test  squamous   90     2 51        no
## 177  89   0 0    test  squamous   50    13 40       yes
## 178  89  15 1    test  squamous   50    13 40       yes
## 179  90   0 0    test smallcell   30     2 69        no
## 180  90  25 1    test smallcell   30     2 69        no
## 181  91   0 0    test smallcell   70    22 36       yes
## 182  91 103 0    test smallcell   70    22 36       yes
## 183  92   0 0    test smallcell   20     4 71        no
## 184  92  21 1    test smallcell   20     4 71        no
## 185  93   0 0    test smallcell   30     2 62        no
## 186  93  13 1    test smallcell   30     2 62        no
## 187  94   0 0    test smallcell   60     2 60        no
## 188  94  87 1    test smallcell   60     2 60        no
## 189  95   0 0    test smallcell   40    36 44       yes
## 190  95   2 1    test smallcell   40    36 44       yes
## 191  96   0 0    test smallcell   30     9 54       yes
## 192  96  20 1    test smallcell   30     9 54       yes
## 193  97   0 0    test smallcell   20    11 66        no
## 194  97   7 1    test smallcell   20    11 66        no
## 195  98   0 0    test smallcell   60     8 49        no
## 196  98  24 1    test smallcell   60     8 49        no
## 197  99   0 0    test smallcell   70     3 72        no
## 198  99  99 1    test smallcell   70     3 72        no
## 199 100   0 0    test smallcell   80     2 68        no
## 200 100   8 1    test smallcell   80     2 68        no
## 201 101   0 0    test smallcell   85     4 62        no
```

```
## 202 101   99 1     test smallcell     85          4 62              no
## 203 102    0 0     test smallcell     70          2 71              no
## 204 102   61 1     test smallcell     70          2 71              no
## 205 103    0 0     test smallcell     70          2 70              no
## 206 103   25 1     test smallcell     70          2 70              no
## 207 104    0 0     test smallcell     70          1 61              no
## 208 104   95 1     test smallcell     70          1 61              no
## 209 105    0 0     test smallcell     50         17 71              no
## 210 105   80 1     test smallcell     50         17 71              no
## 211 106    0 0     test smallcell     30         87 59             yes
## 212 106   51 1     test smallcell     30         87 59             yes
## 213 107    0 0     test smallcell     40          8 67              no
## 214 107   29 1     test smallcell     40          8 67              no
## 215 108    0 0     test    adeno      40          2 60              no
## 216 108   24 1     test    adeno      40          2 60              no
## 217 109    0 0     test    adeno      40          5 69             yes
## 218 109   18 1     test    adeno      40          5 69             yes
## 219 110    0 0     test    adeno      99          3 57              no
## 220 110   83 0     test    adeno      99          3 57              no
## 221 111    0 0     test    adeno      80          3 39              no
## 222 111   31 1     test    adeno      80          3 39              no
## 223 112    0 0     test    adeno      60          5 62              no
## 224 112   51 1     test    adeno      60          5 62              no
## 225 113    0 0     test    adeno      60         22 50             yes
## 226 113   90 1     test    adeno      60         22 50             yes
## 227 114    0 0     test    adeno      60          3 43              no
## 228 114   52 1     test    adeno      60          3 43              no
## 229 115    0 0     test    adeno      60          3 70              no
## 230 115   73 1     test    adeno      60          3 70              no
## 231 116    0 0     test    adeno      50          5 66              no
## 232 116    8 1     test    adeno      50          5 66              no
## 233 117    0 0     test    adeno      70          8 61              no
## 234 117   36 1     test    adeno      70          8 61              no
## 235 118    0 0     test    adeno      10          4 81              no
## 236 118   48 1     test    adeno      10          4 81              no
## 237 119    0 0     test    adeno      40          4 58              no
## 238 119    7 1     test    adeno      40          4 58              no
## 239 120    0 0     test    adeno      70          3 63              no
## 240 120  140 1     test    adeno      70          3 63              no
## 241 121    0 0     test    adeno      90          3 60              no
## 242 121  186 1     test    adeno      90          3 60              no
## 243 122    0 0     test    adeno      80          4 62             yes
## 244 122   84 1     test    adeno      80          4 62             yes
## 245 123    0 0     test    adeno      50         10 42              no
## 246 123   19 1     test    adeno      50         10 42              no
## 247 124    0 0     test    adeno      40          3 69              no
## 248 124   45 1     test    adeno      40          3 69              no
## 249 125    0 0     test    adeno      40          4 63              no
## 250 125   80 1     test    adeno      40          4 63              no
## 251 126    0 0     test    large      60          4 45              no
## 252 126   52 1     test    large      60          4 45              no
## 253 127    0 0     test    large      70         15 68             yes
## 254 127  164 1     test    large      70         15 68             yes
## 255 128    0 0     test    large      30          4 39             yes
```

```
## 256 128   19 1     test      large     30        4  39          yes
## 257 129    0 0     test      large     60       12  66           no
## 258 129   53 1     test      large     60       12  66           no
## 259 130    0 0     test      large     30        5  63           no
## 260 130   15 1     test      large     30        5  63           no
## 261 131    0 0     test      large     60       11  49          yes
## 262 131   43 1     test      large     60       11  49          yes
## 263 132    0 0     test      large     80       10  64          yes
## 264 132  340 1     test      large     80       10  64          yes
## 265 133    0 0     test      large     75        1  65           no
## 266 133  133 1     test      large     75        1  65           no
## 267 134    0 0     test      large     60        5  64           no
## 268 134  111 1     test      large     60        5  64           no
## 269 135    0 0     test      large     70       18  67          yes
## 270 135  231 1     test      large     70       18  67          yes
## 271 136    0 0     test      large     80        4  65           no
## 272 136  378 1     test      large     80        4  65           no
## 273 137    0 0     test      large     30        3  37           no
## 274 137   49 1     test      large     30        3  37           no
```

#Kaplan–Meier survival curve comparing treatment groups

```r
library(survival)
```

```
## Warning: package 'survival' was built under R version 4.4.3
```

```r
library(survminer)
```

```
## Warning: package 'survminer' was built under R version 4.4.3

## Loading required package: ggplot2

## Warning: package 'ggplot2' was built under R version 4.4.3

## Loading required package: ggpubr

## Warning: package 'ggpubr' was built under R version 4.4.3

##
## Attaching package: 'survminer'

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

```r
surv_data <- Surv(time =dataset$TIME, event = dataset$Y )
km_fit <-  survfit(surv_data ~ trt,data = dataset)

km_plot <- ggsurvplot(
  km_fit, data= dataset, legend.title = "Treatment",
  legend.labs = levels(as.factor(dataset$trt)),
  xlab = "Time(days)",
  ylab = "Suvival probability",
  title = "KM-survival curves"

)
```

```
## Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
## i Please use `linewidth` instead.
## i The deprecated feature was likely used in the ggpubr package.
```
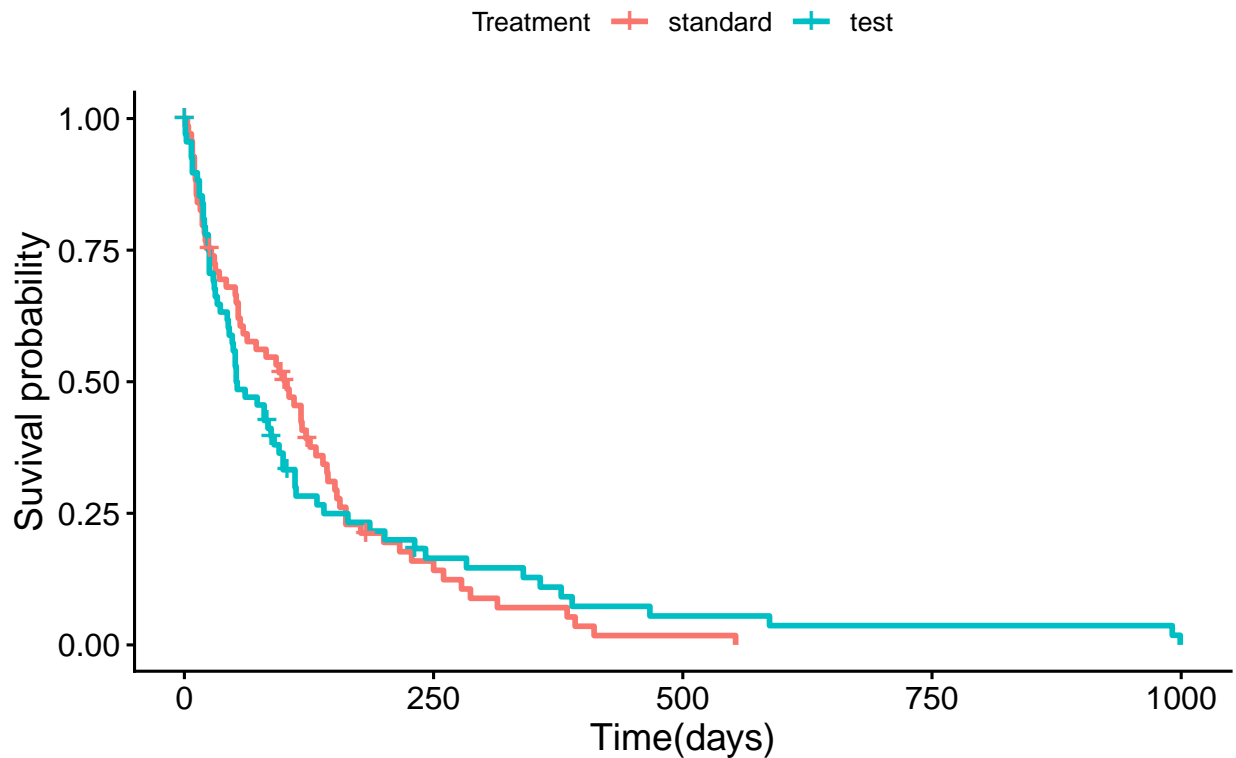
```
##    Please report the issue at <https://github.com/kassambara/ggpubr/issues>.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```
```
km_plot
```

KM−survival curves


```
cox_model <- coxph(surv_data ~ trt + celltype + priortherapy, data = dataset)
summary(cox_model)
```

```
## Call:
## coxph(formula = surv_data ~ trt + celltype + priortherapy, data = dataset)
##
##   n= 274, number of events= 128
##
##                      coef exp(coef) se(coef)      z Pr(>|z|)
## trttest            0.19587   1.21636  0.19725  0.993  0.32072
## celltypelarge     -0.87910   0.41516  0.29590 -2.971  0.00297 **
## celltypesmallcell -0.07639   0.92646  0.26137 -0.292  0.77009
## celltypesquamous  -1.17661   0.30832  0.29992 -3.923 8.74e-05 ***
## priortherapyyes    0.02987   1.03032  0.20596  0.145  0.88469
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##                   exp(coef) exp(-coef) lower .95 upper .95
## trttest              1.2164     0.8221    0.8264    1.7904
## celltypelarge        0.4152     2.4087    0.2325    0.7415
```

```
## celltypesmallcell     0.9265     1.0794     0.5551     1.5463
## celltypesquamous      0.3083     3.2434     0.1713     0.5550
## priortherapyyes       1.0303     0.9706     0.6881     1.5427
##
## Concordance= 0.621  (se = 0.027 )
## Likelihood ratio test= 25.88  on 5 df,    p=9e-05
## Wald test            = 24.78  on 5 df,    p=2e-04
## Score (logrank) test = 26.27  on 5 df,    p=8e-05
```

#3- Interpret hazard ratios and confidence intervals.

Treatment predictors:

- group1 : test
- group2 : standard

The patients that has test treatment an estimated 21.6% higher hazard of daeth than standard treatment.

CI : (0.8264 , 1.7904) The patients that has test treatment has hazard of daeth at least 0.8264 but not more than 1.7904

celltype predictors:

baseline = adeno

1. large celltype

The patients that has large cell an estimated more 41.52% higher hazard of daeth rathar adeno cell.

CI : (0.2325 , 0.7415) The patients that has large cell has hazard of daeth at least 0.2325 but not more than 0.7415

2. smallcell celltype The patients that has smallcell an estimated more 92.64% higher hazard of daeth rathar adeno cell.

CI : (0.5551 , 1.5463) The patients that has smallcell has hazard of daeth at least 0.5551 but not more than 1.5463

3. squamous celltype squamous cell patients have about 69% lower hazard of death compared with adenocarcinoma patients.

CI: (0.1713 , 0.5550) The patients that has squamous cell has hazard of daeth at least 0.1713 but not more than 0.5550

priortherapy:

The patients that response priortherapy an estimated 3.03% higher hazard of daeth than response no.

CI : (0.145 ,0.88469) The patients that response priortherapy has hazard of daeth at least 0.145 but not more than 0.88469

Test proportional hazards assumptions

```
# Test proportional hazards assumptions using Schoenfeld residuals
ph_test <- cox.zph(cox_model)
print(ph_test)
```

```
##              chisq df     p
## trt          0.878  1 0.349
## celltype     9.407  3 0.024
## priortherapy 3.614  1 0.057
## GLOBAL      12.756  5 0.026
```

Proportional hazards were assessed using Schoenfeld residuals. There was no evidence of non-proportionality for treatment (p = 0.35), but the global test indicated deviation from the proportional hazards assumption (GLOBAL p = 0.026), driven primarily by cell type (p = 0.024) and, to a lesser extent, prior therapy (p = 0.057).

#Write a clinical-style interpretation of findings. Clinically, these findings imply that while the overall conclusion regarding lack of a clear survival benefit with the test treatment is likely robust, the prognostic impact of certain tumor cell types may change over time. Interpretations of hazard ratios for cell type should therefore recognize that they represent an average effect over the observed follow-up rather than a strictly time-invariant relationship.