Weighted Survival Analysis for Cyrpto

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##Libraries and Reading in Data

```
# Libraries
library("dplyr")
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library("ggplot2")
library("tidyr")
library("survival")
library("survminer")
```

```
## Loading required package: ggpubr
```

```
##
## Attaching package: 'survminer'
```

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

```
library("PSweight")
library("broom")
library("haven")
library("summarytools")
library("WeightIt")
```

```
## Warning: package 'WeightIt' was built under R version 4.4.2
```

```r
# Read in LP Data
survival <- read_sas("C:/Users/qne4/CDC/NCEZID-MDB - Data Science and Informatics (DSI)/Data Science/pe
```

Clean Data

Analytic Dataset was cleaned in SAS

##Calculating Probability Treatment of Weights (Propensity scoring etc)

```r
# Subsetting variables to create dataframe we want for analysis
propensity = subset(survival, select = c(LOS, only1LP, died2, AGE, race_eth2, std_payor_c,
    PROV_REGION, URBAN_RURAL, beds_grp_c, icd_acutekidney, icd_anemia, icd_HIV,
    icd_hypokalemia, icd_hyponatremia, icd_neutropenia, icd_overweight, icd_transplant,
    any_CSFdrain, med_AMB_any, med_fluc, med_5FC, category  ))

# Frequencies of All Variables (good for categorical variables)
dfSummary(propensity, style = "grid", plain.ascii = TRUE)
```

```
## Data Frame Summary
## propensity
## Dimensions: 1850 x 22
## Duplicates: 0
##
## +----+-----------------+-------------------------+---------------------+----------------------+-----
## | No | Variable        | Stats / Values          | Freqs (% of Valid)  | Graph                | Vali
## +====+=================+=========================+=====================+======================+=====
## | 1  | LOS             | Mean (sd) : 22.8 (22)   | 107 distinct values | :                    | 185
## |    | [numeric]       | min < med < max:        |                     | :                    | (10
## |    |                 | 0 < 17 < 437            |                     | :                    |
## |    |                 | IQR (CV) : 17 (1)       |                     | :                    |
## |    |                 |                         |                     | : .                  |
## +----+-----------------+-------------------------+---------------------+----------------------+-----
## | 2  | only1LP         | Min  : 0                | 0 : 882 (47.7%)     | IIIIIIIII            | 185
## |    | [numeric]       | Mean : 0.5              | 1 : 968 (52.3%)     | IIIIIIIIII           | (10
## |    |                 | Max  : 1                |                     |                      |
## +----+-----------------+-------------------------+---------------------+----------------------+-----
## | 3  | died2           | Min  : 0                | 0 : 1522 (82.3%)    | IIIIIIIIIIIIIIII     | 185
## |    | [numeric]       | Mean : 0.2              | 1 :  328 (17.7%)    | III                  | (10
## |    |                 | Max  : 1                |                     |                      |
## +----+-----------------+-------------------------+---------------------+----------------------+-----
## | 4  | AGE             | Mean (sd) : 50.6 (15.2) | 77 distinct values  |         : :         | 185
## |    | [numeric]       | min < med < max:        |                     |       : : : :       | (10
## |    |                 | 0 < 50 < 89             |                     |       : : : :       |
## |    |                 | IQR (CV) : 23 (0.3)     |                     |     : : : : : : :   |
## |    |                 |                         |                     |   . : : : : : : : . |
## +----+-----------------+-------------------------+---------------------+----------------------+-----
## | 5  | race_eth2       | 1. (Empty string)       | 245 (13.2%)         | II                   | 185
## |    | [character]     | 2. Hispanic             | 390 (21.1%)         | IIII                 | (10
## |    |                 | 3. Non-Hispanic Black   | 472 (25.5%)         | IIIII                |
## |    |                 | 4. Non-Hispanic Other   | 109 ( 5.9%)         | I                    |
## |    |                 | 5. Non-Hispanic White   | 634 (34.3%)         | IIIIII               |
## +----+-----------------+-------------------------+---------------------+----------------------+-----
## | 6  | std_payor_c     | 1. Medicaid             | 705 (38.1%)         | IIIIIII              | 185
```

```
## |    | [character]      | 2. Medicare            | 588 (31.8%)         | IIIIII               | (100
## |    |                  | 3. Other               | 199 (10.8%)         | II                   |
## |    |                  | 4. Private             | 358 (19.4%)         | III                  |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 7  | PROV_REGION      | 1. MIDWEST             | 199 (10.8%)         | II                   | 1850
## |    | [character]      | 2. NORTHEAST           | 298 (16.1%)         | III                  | (100
## |    |                  | 3. SOUTH               | 992 (53.6%)         | IIIIIIIIII           |
## |    |                  | 4. WEST                | 361 (19.5%)         | III                  |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 8  | URBAN_RURAL      | 1. RURAL               |  135 ( 7.3%)        | I                    | 1850
## |    | [character]      | 2. URBAN               | 1715 (92.7%)        | IIIIIIIIIIIIIIIII    | (100
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 9  | beds_grp_c       | 1. 000-199             |  217 (11.7%)        | II                   | 1850
## |    | [character]      | 2. 200-399             |  555 (30.0%)        | IIIIII               | (100
## |    |                  | 3. 400+                | 1078 (58.3%)        | IIIIIIIIII           |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 10 | icd_acutekidney  | Min  : 0               | 0 : 866 (46.8%)     | IIIIIIIII            | 1850
## |    | [numeric]        | Mean : 0.5             | 1 : 984 (53.2%)     | IIIIIIIII            | (100
## |    |                  | Max  : 1               |                     |                      |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 11 | icd_anemia       | Min  : 0               | 0 : 1745 (94.3%)    | IIIIIIIIIIIIIIIII    | 1850
## |    | [numeric]        | Mean : 0.1             | 1 :  105 ( 5.7%)    | I                    | (100
## |    |                  | Max  : 1               |                     |                      |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 12 | icd_HIV          | Min  : 0               | 0 : 919 (49.7%)     | IIIIIIIII            | 1850
## |    | [numeric]        | Mean : 0.5             | 1 : 931 (50.3%)     | IIIIIIIII            | (100
## |    |                  | Max  : 1               |                     |                      |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 13 | icd_hypokalemia  | Min  : 0               | 0 : 886 (47.9%)     | IIIIIIIII            | 1850
## |    | [numeric]        | Mean : 0.5             | 1 : 964 (52.1%)     | IIIIIIIII            | (100
## |    |                  | Max  : 1               |                     |                      |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 14 | icd_hyponatremia | Min  : 0               | 0 : 1232 (66.6%)    | IIIIIIIIIIII         | 1850
## |    | [numeric]        | Mean : 0.3             | 1 :  618 (33.4%)    | IIIIII               | (100
## |    |                  | Max  : 1               |                     |                      |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 15 | icd_neutropenia  | Min  : 0               | 0 : 1740 (94.1%)    | IIIIIIIIIIIIIIIII    | 1850
## |    | [numeric]        | Mean : 0.1             | 1 :  110 ( 5.9%)    | I                    | (100
## |    |                  | Max  : 1               |                     |                      |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 16 | icd_overweight   | Min  : 0               | 0 : 1687 (91.2%)    | IIIIIIIIIIIIIIIII    | 1850
## |    | [numeric]        | Mean : 0.1             | 1 :  163 ( 8.8%)    | I                    | (100
## |    |                  | Max  : 1               |                     |                      |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 17 | icd_transplant   | Min  : 0               | 0 : 1663 (89.9%)    | IIIIIIIIIIIIIIII     | 1850
## |    | [numeric]        | Mean : 0.1             | 1 :  187 (10.1%)    | II                   | (100
## |    |                  | Max  : 1               |                     |                      |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 18 | any_CSFdrain     | Min  : 0               | 0 : 1703 (92.1%)    | IIIIIIIIIIIIIIIII    | 1850
## |    | [numeric]        | Mean : 0.1             | 1 :  147 ( 7.9%)    | I                    | (100
## |    |                  | Max  : 1               |                     |                      |
## +----+------------------+------------------------+---------------------+----------------------+-----
## | 19 | med_AMB_any      | Min  : 0               | 0 :  190 (10.3%)    | II                   | 1850
## |    | [numeric]        | Mean : 0.9             | 1 : 1660 (89.7%)    | IIIIIIIIIIIIIIII     | (100
```

```
## |    |                  | Max  : 1                 |                     |                      |
## +----+------------------+--------------------------+---------------------+----------------------+-----
## | 20 | med_fluc         | Min  : 0                 | 0 :  569 (30.8%)    | IIIIII               | 185
## |    | [numeric]        | Mean : 0.7               | 1 : 1281 (69.2%)    | IIIIIIIIIIII         | (10
## |    |                  | Max  : 1                 |                     |                      |
## +----+------------------+--------------------------+---------------------+----------------------+-----
## | 21 | med_5FC          | Min  : 0                 | 0 :  385 (20.8%)    | IIII                 | 185
## |    | [numeric]        | Mean : 0.8               | 1 : 1465 (79.2%)    | IIIIIIIIIIIIII       | (10
## |    |                  | Max  : 1                 |                     |                      |
## +----+------------------+--------------------------+---------------------+----------------------+-----
## | 22 | category         | 1. HIV                   | 931 (50.3%)         | IIIIIIIII            | 185
## |    | [character]      | 2. NHNT                  | 737 (39.8%)         | IIIIIII              | (10
## |    |                  | 3. Transplant            | 182 ( 9.8%)         | I                    |
## +----+------------------+--------------------------+---------------------+----------------------+-----
```

```r
#Omitting NAs for
#propensity <- na.omit(propensity)

#Converting categorical variables to factor type for regression models
factor.list <- c("race_eth2", "std_payor_c","PROV_REGION","URBAN_RURAL","beds_grp_c")
propensity[,factor.list] <- lapply(propensity[,factor.list],factor)
sapply(propensity, class)
```

```
##              LOS          only1LP            died2              AGE
##        "numeric"        "numeric"        "numeric"        "numeric"
##        race_eth2      std_payor_c      PROV_REGION      URBAN_RURAL
##         "factor"         "factor"         "factor"         "factor"
##       beds_grp_c  icd_acutekidney       icd_anemia          icd_HIV
##         "factor"        "numeric"        "numeric"        "numeric"
##  icd_hypokalemia icd_hyponatremia  icd_neutropenia   icd_overweight
##        "numeric"        "numeric"        "numeric"        "numeric"
##   icd_transplant     any_CSFdrain      med_AMB_any         med_fluc
##        "numeric"        "numeric"        "numeric"        "numeric"
##          med_5FC         category
##        "numeric"      "character"
```

##Calcultaing Propensity Scores

```r
# PS Model
iptw.model=glm(only1LP ~ AGE+ race_eth2+ std_payor_c+ PROV_REGION+ URBAN_RURAL+ beds_grp_c+
               icd_acutekidney+ icd_anemia+ icd_HIV+ icd_hypokalemia+ icd_hyponatremia+
               icd_neutropenia+ icd_overweight+ icd_transplant+ any_CSFdrain+ med_AMB_any+ med_fluc + m
               data = propensity,
               family = binomial(link="logit"))

# Using predictive values and selecting variables to use
new.propensity <-augment(iptw.model,
                         propensity,
                         type.predict = "response") %>%
  rename(propensity=.fitted) %>%
  select(LOS, only1LP, died2, AGE, race_eth2, std_payor_c,
         PROV_REGION, URBAN_RURAL, beds_grp_c, icd_acutekidney, icd_anemia, icd_HIV,
         icd_hypokalemia, icd_hyponatremia, icd_neutropenia, icd_overweight, icd_transplant,
```

```
         any_CSFdrain, med_AMB_any, med_fluc, med_5FC, propensity, category)

# Viewing first rows of modified dataframe
head(new.propensity)
```

```
## # A tibble: 6 x 23
##     LOS only1LP died2   AGE race_eth2        std_payor_c PROV_REGION URBAN_RURAL
##   <dbl>   <dbl> <dbl> <dbl> <fct>             <fct>       <fct>       <fct>
## 1    17       1     0    41 "Non-Hispanic W~ Private     NORTHEAST   URBAN
## 2    98       0     0    49 "Non-Hispanic W~ Medicaid    SOUTH       URBAN
## 3    24       0     0    63 "Non-Hispanic W~ Private     MIDWEST     URBAN
## 4    14       1     0    76 "Non-Hispanic W~ Medicare    SOUTH       URBAN
## 5    17       1     0    62 ""               Private     NORTHEAST   URBAN
## 6    55       0     0    23 "Non-Hispanic W~ Medicaid    NORTHEAST   URBAN
## # i 15 more variables: beds_grp_c <fct>, icd_acutekidney <dbl>,
## #   icd_anemia <dbl>, icd_HIV <dbl>, icd_hypokalemia <dbl>,
## #   icd_hyponatremia <dbl>, icd_neutropenia <dbl>, icd_overweight <dbl>,
## #   icd_transplant <dbl>, any_CSFdrain <dbl>, med_AMB_any <dbl>,
## #   med_fluc <dbl>, med_5FC <dbl>, propensity <dbl>, category <chr>
```

##Generate probability weights

Creating unstable, stable, treated, and overlapping weights Using indicator function for binary exposure, only1LP
For example, when only1LP = 0 or 1 : 0: uw = [0] + [1 - 0 /(1-PS(i)] = 1/(1-propensity) 1: uw = [1/PS(i)] + [0] = 1/propesnity

```
ipw.data<-new.propensity %>%
  mutate(uw=(only1LP/propensity)+(1-only1LP)/(1-propensity)) %>%

  mutate(sw=mean(only1LP)*(only1LP/propensity)+mean(only1LP)*(1-only1LP)/(1-propensity)) %>%

  mutate(tr=propensity*(only1LP/propensity)+propensity*(1-only1LP)/(1-propensity)) %>%

  mutate(ov=propensity*(1-propensity)*(only1LP/propensity)+
           propensity*(1-propensity)*(1-only1LP)/(1-propensity))
```

##Outcome Regression Models for each weight

```
# NOTE: It's ok to include weights and adjust for covariates.

model1.fit=coxph(Surv(LOS, died2) ~ only1LP + AGE+ race_eth2+ std_payor_c+ PROV_REGION+ URBAN_RURAL+ bed
                   icd_acutekidney+ icd_anemia+ icd_HIV+ icd_hypokalemia+ icd_hyponatremia+
                   icd_neutropenia+ icd_overweight+ icd_transplant+ any_CSFdrain+ med_AMB_any+ med_fluc
                 data = ipw.data,
               weights = uw)

model2.fit=coxph(Surv(LOS, died2) ~ only1LP + AGE+ race_eth2+ std_payor_c+ PROV_REGION+ URBAN_RURAL+ bed
                   icd_acutekidney+ icd_anemia+ icd_HIV+ icd_hypokalemia+ icd_hyponatremia+
                   icd_neutropenia+ icd_overweight+ icd_transplant+ any_CSFdrain+ med_AMB_any+ med_fluc
                 data = ipw.data,
                 weights = sw)
```

```
model3.fit=coxph(Surv(LOS, died2) ~ only1LP + AGE+ race_eth2+ std_payor_c+ PROV_REGION+ URBAN_RURAL+ bed
                   icd_acutekidney+ icd_anemia+ icd_HIV+ icd_hypokalemia+ icd_hyponatremia+
                   icd_neutropenia+ icd_overweight+ icd_transplant+ any_CSFdrain+ med_AMB_any+ med_fluc
                 data = ipw.data,
                 weights = tr)

model4.fit=coxph(Surv(LOS, died2) ~ only1LP + AGE+ race_eth2+ std_payor_c+ PROV_REGION+ URBAN_RURAL+ bed
                   icd_acutekidney+ icd_anemia+ icd_HIV+ icd_hypokalemia+ icd_hyponatremia+
                   icd_neutropenia+ icd_overweight+ icd_transplant+ any_CSFdrain+ med_AMB_any+ med_fluc
                 data = ipw.data,
                 weights = ov)



# Check fit
tidy(model1.fit)
```

```
## # A tibble: 27 x 6
##    term                          estimate std.error robust.se statistic  p.value
##    <chr>                            <dbl>     <dbl>     <dbl>     <dbl>    <dbl>
##  1 only1LP                       1.01       0.0831    0.127    7.91     2.53e-15
##  2 AGE                           0.0285     0.00378   0.00572  4.99     5.94e- 7
##  3 race_eth2Hispanic             0.125      0.149     0.222    0.564    5.73e- 1
##  4 race_eth2Non-Hispanic Black -0.000164   0.148     0.226   -0.000724 9.99e- 1
##  5 race_eth2Non-Hispanic Other -0.128      0.200     0.379   -0.337    7.36e- 1
##  6 race_eth2Non-Hispanic White  0.225      0.138     0.213    1.05     2.93e- 1
##  7 std_payor_cMedicare         -0.109      0.123     0.198   -0.548    5.83e- 1
##  8 std_payor_cOther             0.112      0.151     0.252    0.446    6.55e- 1
##  9 std_payor_cPrivate          -0.259      0.131     0.197   -1.31     1.89e- 1
## 10 PROV_REGIONNORTHEAST        -0.296      0.156     0.276   -1.07     2.85e- 1
## # i 17 more rows
```

```
tidy(model2.fit)
```

```
## # A tibble: 27 x 6
##    term                          estimate std.error robust.se statistic  p.value
##    <chr>                            <dbl>     <dbl>     <dbl>     <dbl>    <dbl>
##  1 only1LP                       1.01       0.115     0.127    7.91     2.53e-15
##  2 AGE                           0.0285     0.00522   0.00572  4.99     5.94e- 7
##  3 race_eth2Hispanic             0.125      0.206     0.222    0.564    5.73e- 1
##  4 race_eth2Non-Hispanic Black -0.000164   0.205     0.226   -0.000724 9.99e- 1
##  5 race_eth2Non-Hispanic Other -0.128      0.276     0.379   -0.337    7.36e- 1
##  6 race_eth2Non-Hispanic White  0.225      0.191     0.213    1.05     2.93e- 1
##  7 std_payor_cMedicare         -0.109      0.170     0.198   -0.548    5.83e- 1
##  8 std_payor_cOther             0.112      0.209     0.252    0.446    6.55e- 1
##  9 std_payor_cPrivate          -0.259      0.181     0.197   -1.31     1.89e- 1
## 10 PROV_REGIONNORTHEAST        -0.296      0.216     0.276   -1.07     2.85e- 1
## # i 17 more rows
```

```
tidy(model3.fit)
```

```
## # A tibble: 27 x 6
```

```
##    term                          estimate std.error robust.se statistic  p.value
##    <chr>                            <dbl>     <dbl>     <dbl>     <dbl>    <dbl>
##  1 only1LP                       1.04      0.114     0.133      7.76   8.26e-15
##  2 AGE                           0.0313    0.00521   0.00591    5.30   1.13e- 7
##  3 race_eth2Hispanic             0.136     0.203     0.219      0.622  5.34e- 1
##  4 race_eth2Non-Hispanic Black -0.00334    0.201     0.232     -0.0144 9.89e- 1
##  5 race_eth2Non-Hispanic Other -0.122      0.289     0.361     -0.338  7.35e- 1
##  6 race_eth2Non-Hispanic White  0.302      0.190     0.211      1.43   1.53e- 1
##  7 std_payor_cMedicare         -0.226      0.166     0.208     -1.09   2.77e- 1
##  8 std_payor_cOther             0.0573     0.214     0.257      0.222  8.24e- 1
##  9 std_payor_cPrivate          -0.247      0.183     0.207     -1.20   2.32e- 1
## 10 PROV_REGIONNORTHEAST        -0.287      0.218     0.275     -1.04   2.97e- 1
## # i 17 more rows
```

```
tidy(model4.fit)
```

```
## # A tibble: 27 x 6
##    term                          estimate std.error robust.se statistic  p.value
##    <chr>                            <dbl>     <dbl>     <dbl>     <dbl>    <dbl>
##  1 only1LP                        0.982     0.176     0.126       7.78  7.01e-15
##  2 AGE                            0.0263    0.00796   0.00564     4.66  3.11e- 6
##  3 race_eth2Hispanic              0.174     0.314     0.224       0.776 4.38e- 1
##  4 race_eth2Non-Hispanic Black    0.0511    0.315     0.225       0.227 8.20e- 1
##  5 race_eth2Non-Hispanic Other   -0.258     0.442     0.351      -0.736 4.62e- 1
##  6 race_eth2Non-Hispanic White    0.227     0.293     0.217       1.05  2.95e- 1
##  7 std_payor_cMedicare           -0.0396    0.262     0.191      -0.207 8.36e- 1
##  8 std_payor_cOther               0.158     0.315     0.247       0.638 5.23e- 1
##  9 std_payor_cPrivate            -0.233     0.277     0.199      -1.17  2.41e- 1
## 10 PROV_REGIONNORTHEAST          -0.262     0.339     0.260      -1.01  3.14e- 1
## # i 17 more rows
```

```
# Adjusted Cox Regression estimates after weighting:
summary(model1.fit)
```

```
## Call:
## coxph(formula = Surv(LOS, died2) ~ only1LP + AGE + race_eth2 +
##     std_payor_c + PROV_REGION + URBAN_RURAL + beds_grp_c + icd_acutekidney +
##     icd_anemia + icd_HIV + icd_hypokalemia + icd_hyponatremia +
##     icd_neutropenia + icd_overweight + icd_transplant + any_CSFdrain +
##     med_AMB_any + med_fluc + med_5FC, data = ipw.data, weights = uw)
##
##   n= 1850, number of events= 328
##
##                                  coef  exp(coef)   se(coef)  robust se      z
## only1LP                     1.0055920  2.7335250  0.0830804  0.1270913  7.912
## AGE                         0.0285389  1.0289500  0.0037771  0.0057158  4.993
## race_eth2Hispanic           0.1251760  1.1333479  0.1488294  0.2219202  0.564
## race_eth2Non-Hispanic Black -0.0001638  0.9998362  0.1483265  0.2261207 -0.001
## race_eth2Non-Hispanic Other -0.1276386  0.8801714  0.1996505  0.3792130 -0.337
## race_eth2Non-Hispanic White  0.2247269  1.2519808  0.1384862  0.2134957  1.053
## std_payor_cMedicare         -0.1085958  0.8970929  0.1229924  0.1979964 -0.548
## std_payor_cOther             0.1122464  1.1187885  0.1509789  0.2515261  0.446
## std_payor_cPrivate          -0.2593578  0.7715469  0.1311780  0.1973391 -1.314
```

```
## PROV_REGIONNORTHEAST        -0.2955777  0.7441016  0.1559669  0.2761962 -1.070
## PROV_REGIONSOUTH             0.0881860  1.0921913  0.1275269  0.2304330  0.383
## PROV_REGIONWEST              0.1407656  1.1511548  0.1641099  0.2768647  0.508
## URBAN_RURALURBAN             0.0069167  1.0069407  0.1741267  0.3074358  0.022
## beds_grp_c200-399            0.1712837  1.1868274  0.1657407  0.2336078  0.733
## beds_grp_c400+               0.4210233  1.5235197  0.1582431  0.2289840  1.839
## icd_acutekidney              0.0493077  1.0505435  0.0839347  0.1286220  0.383
## icd_anemia                   0.0795786  1.0828307  0.1584830  0.2493177  0.319
## icd_HIV                      0.1627728  1.1767693  0.1003955  0.1641202  0.992
## icd_hypokalemia             -0.3445492  0.7085397  0.0821455  0.1250829 -2.755
## icd_hyponatremia             0.0282592  1.0286623  0.0847537  0.1294341  0.218
## icd_neutropenia             -0.5718163  0.5644992  0.2094878  0.2659075 -2.150
## icd_overweight               0.0330457  1.0335978  0.1335655  0.2028854  0.163
## icd_transplant              -0.3279955  0.7203663  0.1377843  0.2067493 -1.586
## any_CSFdrain                -0.2054435  0.8142861  0.1328549  0.2272869 -0.904
## med_AMB_any                  0.7337967  2.0829740  0.1746634  0.2938947  2.497
## med_fluc                    -1.3027920  0.2717719  0.0868648  0.1347959 -9.665
## med_5FC                     -0.5446762  0.5800295  0.1105506  0.1823430 -2.987
##                            Pr(>|z|)
## only1LP                    2.53e-15 ***
## AGE                        5.94e-07 ***
## race_eth2Hispanic           0.57271
## race_eth2Non-Hispanic Black  0.99942
## race_eth2Non-Hispanic Other  0.73643
## race_eth2Non-Hispanic White  0.29252
## std_payor_cMedicare         0.58337
## std_payor_cOther            0.65541
## std_payor_cPrivate          0.18875
## PROV_REGIONNORTHEAST        0.28454
## PROV_REGIONSOUTH            0.70194
## PROV_REGIONWEST             0.61115
## URBAN_RURALURBAN            0.98205
## beds_grp_c200-399           0.46343
## beds_grp_c400+              0.06597 .
## icd_acutekidney             0.70146
## icd_anemia                  0.74959
## icd_HIV                     0.32130
## icd_hypokalemia             0.00588 **
## icd_hyponatremia            0.82717
## icd_neutropenia             0.03152 *
## icd_overweight              0.87061
## icd_transplant              0.11264
## any_CSFdrain                0.36605
## med_AMB_any                 0.01253 *
## med_fluc                    < 2e-16 ***
## med_5FC                     0.00282 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##                            exp(coef) exp(-coef) lower .95 upper .95
## only1LP                       2.7335     0.3658    2.1308    3.5067
## AGE                           1.0289     0.9719    1.0175    1.0405
## race_eth2Hispanic             1.1333     0.8823    0.7336    1.7509
## race_eth2Non-Hispanic Black   0.9998     1.0002    0.6419    1.5574
```

```
## race_eth2Non-Hispanic Other    0.8802     1.1361    0.4186    1.8508
## race_eth2Non-Hispanic White    1.2520     0.7987    0.8239    1.9025
## std_payor_cMedicare            0.8971     1.1147    0.6086    1.3224
## std_payor_cOther               1.1188     0.8938    0.6834    1.8317
## std_payor_cPrivate             0.7715     1.2961    0.5241    1.1359
## PROV_REGIONNORTHEAST           0.7441     1.3439    0.4330    1.2786
## PROV_REGIONSOUTH               1.0922     0.9156    0.6953    1.7157
## PROV_REGIONWEST                1.1512     0.8687    0.6691    1.9806
## URBAN_RURALURBAN               1.0069     0.9931    0.5512    1.8395
## beds_grp_c200-399              1.1868     0.8426    0.7508    1.8760
## beds_grp_c400+                 1.5235     0.6564    0.9726    2.3865
## icd_acutekidney                1.0505     0.9519    0.8165    1.3518
## icd_anemia                     1.0828     0.9235    0.6643    1.7651
## icd_HIV                        1.1768     0.8498    0.8531    1.6233
## icd_hypokalemia                0.7085     1.4114    0.5545    0.9054
## icd_hyponatremia               1.0287     0.9721    0.7982    1.3257
## icd_neutropenia                0.5645     1.7715    0.3352    0.9506
## icd_overweight                 1.0336     0.9675    0.6945    1.5383
## icd_transplant                 0.7204     1.3882    0.4804    1.0803
## any_CSFdrain                   0.8143     1.2281    0.5216    1.2713
## med_AMB_any                    2.0830     0.4801    1.1709    3.7055
## med_fluc                       0.2718     3.6796    0.2087    0.3540
## med_5FC                        0.5800     1.7241    0.4057    0.8292
##
## Concordance= 0.773  (se = 0.014 )
## Likelihood ratio test= 530.1  on 27 df,   p=<2e-16
## Wald test            = 249.2  on 27 df,   p=<2e-16
## Score (logrank) test = 564.1  on 27 df,   p=<2e-16,   Robust = 165.6  p=<2e-16
##
##   (Note: the likelihood ratio and score tests assume independence of
##      observations within a cluster, the Wald and robust score tests do not).
```

```
summary(model2.fit)
```

```
## Call:
## coxph(formula = Surv(LOS, died2) ~ only1LP + AGE + race_eth2 +
##     std_payor_c + PROV_REGION + URBAN_RURAL + beds_grp_c + icd_acutekidney +
##     icd_anemia + icd_HIV + icd_hypokalemia + icd_hyponatremia +
##     icd_neutropenia + icd_overweight + icd_transplant + any_CSFdrain +
##     med_AMB_any + med_fluc + med_5FC, data = ipw.data, weights = sw)
##
##   n= 1850, number of events= 328
##
##                                  coef  exp(coef)   se(coef)  robust se      z
## only1LP                     1.0055920  2.7335250  0.1148541  0.1270913  7.912
## AGE                         0.0285389  1.0289500  0.0052216  0.0057158  4.993
## race_eth2Hispanic           0.1251760  1.1333479  0.2057486  0.2219202  0.564
## race_eth2Non-Hispanic Black -0.0001638  0.9998362  0.2050534  0.2261207 -0.001
## race_eth2Non-Hispanic Other -0.1276386  0.8801714  0.2760060  0.3792130 -0.337
## race_eth2Non-Hispanic White  0.2247269  1.2519808  0.1914498  0.2134957  1.053
## std_payor_cMedicare         -0.1085958  0.8970929  0.1700304  0.1979964 -0.548
## std_payor_cOther             0.1122464  1.1187885  0.2087202  0.2515261  0.446
## std_payor_cPrivate          -0.2593578  0.7715469  0.1813465  0.1973391 -1.314
## PROV_REGIONNORTHEAST        -0.2955777  0.7441016  0.2156159  0.2761962 -1.070
```

```
## PROV_REGIONSOUTH             0.0881860  1.0921913  0.1762991  0.2304330  0.383
## PROV_REGIONWEST              0.1407656  1.1511548  0.2268731  0.2768647  0.508
## URBAN_RURALURBAN             0.0069167  1.0069407  0.2407208  0.3074358  0.022
## beds_grp_c200-399            0.1712837  1.1868274  0.2291276  0.2336078  0.733
## beds_grp_c400+               0.4210233  1.5235197  0.2187626  0.2289840  1.839
## icd_acutekidney              0.0493077  1.0505435  0.1160352  0.1286220  0.383
## icd_anemia                   0.0795786  1.0828307  0.2190942  0.2493177  0.319
## icd_HIV                      0.1627728  1.1767693  0.1387913  0.1641202  0.992
## icd_hypokalemia             -0.3445492  0.7085397  0.1135617  0.1250829 -2.755
## icd_hyponatremia             0.0282592  1.0286623  0.1171675  0.1294341  0.218
## icd_neutropenia             -0.5718163  0.5644992  0.2896056  0.2659075 -2.150
## icd_overweight               0.0330457  1.0335978  0.1846471  0.2028854  0.163
## icd_transplant              -0.3279955  0.7203663  0.1904794  0.2067493 -1.586
## any_CSFdrain                -0.2054435  0.8142861  0.1836648  0.2272869 -0.904
## med_AMB_any                  0.7337967  2.0829740  0.2414627  0.2938947  2.497
## med_fluc                    -1.3027920  0.2717719  0.1200860  0.1347959 -9.665
## med_5FC                     -0.5446762  0.5800295  0.1528302  0.1823430 -2.987
##                             Pr(>|z|)
## only1LP                     2.53e-15 ***
## AGE                         5.94e-07 ***
## race_eth2Hispanic            0.57271
## race_eth2Non-Hispanic Black  0.99942
## race_eth2Non-Hispanic Other  0.73643
## race_eth2Non-Hispanic White  0.29252
## std_payor_cMedicare          0.58337
## std_payor_cOther             0.65541
## std_payor_cPrivate           0.18875
## PROV_REGIONNORTHEAST         0.28454
## PROV_REGIONSOUTH             0.70194
## PROV_REGIONWEST              0.61115
## URBAN_RURALURBAN             0.98205
## beds_grp_c200-399            0.46343
## beds_grp_c400+               0.06597 .
## icd_acutekidney              0.70146
## icd_anemia                   0.74959
## icd_HIV                      0.32130
## icd_hypokalemia              0.00588 **
## icd_hyponatremia             0.82717
## icd_neutropenia              0.03152 *
## icd_overweight               0.87061
## icd_transplant               0.11264
## any_CSFdrain                 0.36605
## med_AMB_any                  0.01253 *
## med_fluc                     < 2e-16 ***
## med_5FC                      0.00282 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##                             exp(coef) exp(-coef) lower .95 upper .95
## only1LP                        2.7335     0.3658    2.1308    3.5067
## AGE                            1.0289     0.9719    1.0175    1.0405
## race_eth2Hispanic              1.1333     0.8823    0.7336    1.7509
## race_eth2Non-Hispanic Black    0.9998     1.0002    0.6419    1.5574
## race_eth2Non-Hispanic Other    0.8802     1.1361    0.4186    1.8508
```

```
## race_eth2Non-Hispanic White    1.2520     0.7987    0.8239    1.9025
## std_payor_cMedicare            0.8971     1.1147    0.6086    1.3224
## std_payor_cOther               1.1188     0.8938    0.6834    1.8317
## std_payor_cPrivate             0.7715     1.2961    0.5241    1.1359
## PROV_REGIONNORTHEAST           0.7441     1.3439    0.4330    1.2786
## PROV_REGIONSOUTH               1.0922     0.9156    0.6953    1.7157
## PROV_REGIONWEST                1.1512     0.8687    0.6691    1.9806
## URBAN_RURALURBAN               1.0069     0.9931    0.5512    1.8395
## beds_grp_c200-399              1.1868     0.8426    0.7508    1.8760
## beds_grp_c400+                 1.5235     0.6564    0.9726    2.3865
## icd_acutekidney                1.0505     0.9519    0.8165    1.3518
## icd_anemia                     1.0828     0.9235    0.6643    1.7651
## icd_HIV                        1.1768     0.8498    0.8531    1.6233
## icd_hypokalemia                0.7085     1.4114    0.5545    0.9054
## icd_hyponatremia               1.0287     0.9721    0.7982    1.3257
## icd_neutropenia                0.5645     1.7715    0.3352    0.9506
## icd_overweight                 1.0336     0.9675    0.6945    1.5383
## icd_transplant                 0.7204     1.3882    0.4804    1.0803
## any_CSFdrain                   0.8143     1.2281    0.5216    1.2713
## med_AMB_any                    2.0830     0.4801    1.1709    3.7055
## med_fluc                       0.2718     3.6796    0.2087    0.3540
## med_5FC                        0.5800     1.7241    0.4057    0.8292
##
## Concordance= 0.773  (se = 0.014 )
## Likelihood ratio test= 277.4  on 27 df,   p=<2e-16
## Wald test            = 249.2  on 27 df,   p=<2e-16
## Score (logrank) test = 295.2  on 27 df,   p=<2e-16,   Robust = 165.6  p=<2e-16
##
##   (Note: the likelihood ratio and score tests assume independence of
##      observations within a cluster, the Wald and robust score tests do not).
```

```
summary(model3.fit)
```

```
## Call:
## coxph(formula = Surv(LOS, died2) ~ only1LP + AGE + race_eth2 +
##     std_payor_c + PROV_REGION + URBAN_RURAL + beds_grp_c + icd_acutekidney +
##     icd_anemia + icd_HIV + icd_hypokalemia + icd_hyponatremia +
##     icd_neutropenia + icd_overweight + icd_transplant + any_CSFdrain +
##     med_AMB_any + med_fluc + med_5FC, data = ipw.data, weights = tr)
##
##   n= 1850, number of events= 328
##
##                                 coef exp(coef)  se(coef) robust se      z
## only1LP                     1.035618  2.816847  0.113758  0.133396  7.764
## AGE                         0.031321  1.031817  0.005207  0.005905  5.304
## race_eth2Hispanic           0.136048  1.145737  0.203487  0.218575  0.622
## race_eth2Non-Hispanic Black -0.003337  0.996669  0.200870  0.232244 -0.014
## race_eth2Non-Hispanic Other -0.122310  0.884874  0.289397  0.361371 -0.338
## race_eth2Non-Hispanic White  0.302019  1.352587  0.190090  0.211163  1.430
## std_payor_cMedicare         -0.226061  0.797669  0.166026  0.207921 -1.087
## std_payor_cOther             0.057260  1.058931  0.214372  0.257497  0.222
## std_payor_cPrivate          -0.247289  0.780915  0.182831  0.206830 -1.196
## PROV_REGIONNORTHEAST        -0.286848  0.750626  0.217593  0.275093 -1.043
## PROV_REGIONSOUTH             0.117079  1.124208  0.185561  0.238974  0.490
```

```
## PROV_REGIONWEST              0.100407  1.105621  0.235570  0.278956  0.360
## URBAN_RURALURBAN             0.063757  1.065834  0.269366  0.271388  0.235
## beds_grp_c200-399            0.104292  1.109924  0.217032  0.231792  0.450
## beds_grp_c400+               0.381894  1.465057  0.207691  0.224703  1.700
## icd_acutekidney              0.046548  1.047649  0.113944  0.130099  0.358
## icd_anemia                   0.008655  1.008693  0.226218  0.305879  0.028
## icd_HIV                      0.119889  1.127371  0.135108  0.171564  0.699
## icd_hypokalemia             -0.378453  0.684920  0.112227  0.130383 -2.903
## icd_hyponatremia             0.001556  1.001558  0.118530  0.132049  0.012
## icd_neutropenia             -0.417444  0.658728  0.285857  0.252646 -1.652
## icd_overweight               0.006088  1.006106  0.197430  0.203514  0.030
## icd_transplant              -0.241975  0.785075  0.187178  0.205145 -1.180
## any_CSFdrain                -0.118809  0.887978  0.186119  0.249045 -0.477
## med_AMB_any                  0.834348  2.303312  0.209718  0.302574  2.758
## med_fluc                    -1.191671  0.303713  0.118713  0.142732 -8.349
## med_5FC                     -0.591475  0.553510  0.137867  0.187684 -3.151
##                            Pr(>|z|)
## only1LP                    8.26e-15 ***
## AGE                        1.13e-07 ***
## race_eth2Hispanic           0.53366
## race_eth2Non-Hispanic Black  0.98854
## race_eth2Non-Hispanic Other  0.73502
## race_eth2Non-Hispanic White  0.15264
## std_payor_cMedicare         0.27693
## std_payor_cOther            0.82403
## std_payor_cPrivate          0.23185
## PROV_REGIONNORTHEAST        0.29707
## PROV_REGIONSOUTH            0.62419
## PROV_REGIONWEST             0.71889
## URBAN_RURALURBAN            0.81426
## beds_grp_c200-399           0.65276
## beds_grp_c400+              0.08922 .
## icd_acutekidney             0.72050
## icd_anemia                  0.97743
## icd_HIV                     0.48468
## icd_hypokalemia             0.00370 **
## icd_hyponatremia            0.99060
## icd_neutropenia             0.09848 .
## icd_overweight              0.97614
## icd_transplant              0.23818
## any_CSFdrain                0.63332
## med_AMB_any                 0.00582 **
## med_fluc                    < 2e-16 ***
## med_5FC                     0.00162 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##                            exp(coef) exp(-coef) lower .95 upper .95
## only1LP                       2.8168     0.3550    2.1688    3.6586
## AGE                           1.0318     0.9692    1.0199    1.0438
## race_eth2Hispanic             1.1457     0.8728    0.7465    1.7585
## race_eth2Non-Hispanic Black   0.9967     1.0033    0.6322    1.5712
## race_eth2Non-Hispanic Other   0.8849     1.1301    0.4358    1.7967
## race_eth2Non-Hispanic White   1.3526     0.7393    0.8942    2.0460
```

```
## std_payor_cMedicare            0.7977     1.2537    0.5307    1.1990
## std_payor_cOther               1.0589     0.9443    0.6393    1.7541
## std_payor_cPrivate             0.7809     1.2805    0.5207    1.1713
## PROV_REGIONNORTHEAST           0.7506     1.3322    0.4378    1.2870
## PROV_REGIONSOUTH               1.1242     0.8895    0.7038    1.7958
## PROV_REGIONWEST                1.1056     0.9045    0.6400    1.9101
## URBAN_RURALURBAN               1.0658     0.9382    0.6262    1.8142
## beds_grp_c200-399              1.1099     0.9010    0.7047    1.7482
## beds_grp_c400+                 1.4651     0.6826    0.9432    2.2757
## icd_acutekidney                1.0476     0.9545    0.8118    1.3519
## icd_anemia                     1.0087     0.9914    0.5539    1.8371
## icd_HIV                        1.1274     0.8870    0.8054    1.5780
## icd_hypokalemia                0.6849     1.4600    0.5305    0.8843
## icd_hyponatremia               1.0016     0.9984    0.7732    1.2974
## icd_neutropenia                0.6587     1.5181    0.4015    1.0808
## icd_overweight                 1.0061     0.9939    0.6752    1.4993
## icd_transplant                 0.7851     1.2738    0.5252    1.1736
## any_CSFdrain                   0.8880     1.1262    0.5450    1.4467
## med_AMB_any                    2.3033     0.4342    1.2729    4.1678
## med_fluc                       0.3037     3.2926    0.2296    0.4018
## med_5FC                        0.5535     1.8067    0.3831    0.7996
##
## Concordance= 0.766  (se = 0.015 )
## Likelihood ratio test= 279.6  on 27 df,   p=<2e-16
## Wald test            = 228.7  on 27 df,   p=<2e-16
## Score (logrank) test = 288  on 27 df,   p=<2e-16,   Robust = 151.4  p=<2e-16
##
##   (Note: the likelihood ratio and score tests assume independence of
##      observations within a cluster, the Wald and robust score tests do not).
```

```
summary(model4.fit)
```

```
## Call:
## coxph(formula = Surv(LOS, died2) ~ only1LP + AGE + race_eth2 +
##     std_payor_c + PROV_REGION + URBAN_RURAL + beds_grp_c + icd_acutekidney +
##     icd_anemia + icd_HIV + icd_hypokalemia + icd_hyponatremia +
##     icd_neutropenia + icd_overweight + icd_transplant + any_CSFdrain +
##     med_AMB_any + med_fluc + med_5FC, data = ipw.data, weights = ov)
##
##   n= 1850, number of events= 328
##
##                                 coef exp(coef)  se(coef) robust se       z
## only1LP                     0.982100  2.670058  0.175794  0.126165   7.784
## AGE                         0.026302  1.026651  0.007961  0.005640   4.663
## race_eth2Hispanic           0.173876  1.189908  0.313595  0.224174   0.776
## race_eth2Non-Hispanic Black 0.051076  1.052403  0.315450  0.225005   0.227
## race_eth2Non-Hispanic Other -0.258212  0.772432  0.441704  0.350731  -0.736
## race_eth2Non-Hispanic White  0.226923  1.254733  0.292521  0.216685   1.047
## std_payor_cMedicare         -0.039564  0.961208  0.262326  0.191406  -0.207
## std_payor_cOther             0.157776  1.170904  0.315264  0.247234   0.638
## std_payor_cPrivate          -0.233023  0.792135  0.276567  0.198941  -1.171
## PROV_REGIONNORTHEAST        -0.262086  0.769445  0.338594  0.260083  -1.008
## PROV_REGIONSOUTH             0.101003  1.106280  0.273426  0.211770   0.477
## PROV_REGIONWEST              0.152068  1.164239  0.349654  0.262427   0.579
```

```
## URBAN_RURALURBAN             0.084350  1.088009  0.383539  0.276521   0.305
## beds_grp_c200-399            0.127729  1.136245  0.348062  0.236726   0.540
## beds_grp_c400+               0.367823  1.444586  0.331257  0.228983   1.606
## icd_acutekidney              0.097135  1.102009  0.178689  0.125672   0.773
## icd_anemia                   0.113947  1.120693  0.341544  0.235553   0.484
## icd_HIV                      0.155538  1.168287  0.213930  0.158879   0.979
## icd_hypokalemia             -0.344126  0.708840  0.173245  0.123953  -2.776
## icd_hyponatremia            -0.006288  0.993732  0.178078  0.127645  -0.049
## icd_neutropenia             -0.575525  0.562409  0.443066  0.273723  -2.103
## icd_overweight               0.070503  1.073048  0.278702  0.195223   0.361
## icd_transplant              -0.348750  0.705570  0.293767  0.211304  -1.650
## any_CSFdrain                -0.193767  0.823850  0.279449  0.218507  -0.887
## med_AMB_any                  0.684277  1.982338  0.418904  0.289781   2.361
## med_fluc                    -1.327147  0.265233  0.183275  0.131217 -10.114
## med_5FC                     -0.540296  0.582576  0.247942  0.175734  -3.075
##                             Pr(>|z|)
## only1LP                     7.01e-15 ***
## AGE                         3.11e-06 ***
## race_eth2Hispanic            0.43797
## race_eth2Non-Hispanic Black  0.82042
## race_eth2Non-Hispanic Other  0.46160
## race_eth2Non-Hispanic White  0.29499
## std_payor_cMedicare          0.83624
## std_payor_cOther             0.52337
## std_payor_cPrivate           0.24147
## PROV_REGIONNORTHEAST         0.31360
## PROV_REGIONSOUTH             0.63340
## PROV_REGIONWEST              0.56227
## URBAN_RURALURBAN             0.76034
## beds_grp_c200-399            0.58950
## beds_grp_c400+               0.10820
## icd_acutekidney              0.43957
## icd_anemia                   0.62857
## icd_HIV                      0.32759
## icd_hypokalemia              0.00550 **
## icd_hyponatremia             0.96071
## icd_neutropenia              0.03550 *
## icd_overweight               0.71799
## icd_transplant               0.09885 .
## any_CSFdrain                 0.37520
## med_AMB_any                  0.01821 *
## med_fluc                     < 2e-16 ***
## med_5FC                      0.00211 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##                             exp(coef) exp(-coef) lower .95 upper .95
## only1LP                        2.6701     0.3745    2.0851    3.4191
## AGE                            1.0267     0.9740    1.0154    1.0381
## race_eth2Hispanic              1.1899     0.8404    0.7668    1.8464
## race_eth2Non-Hispanic Black    1.0524     0.9502    0.6771    1.6357
## race_eth2Non-Hispanic Other    0.7724     1.2946    0.3884    1.5360
## race_eth2Non-Hispanic White    1.2547     0.7970    0.8206    1.9186
## std_payor_cMedicare            0.9612     1.0404    0.6605    1.3988
```

```
## std_payor_cOther               1.1709     0.8540    0.7212    1.9009
## std_payor_cPrivate             0.7921     1.2624    0.5364    1.1699
## PROV_REGIONNORTHEAST           0.7694     1.2996    0.4622    1.2810
## PROV_REGIONSOUTH               1.1063     0.9039    0.7305    1.6754
## PROV_REGIONWEST                1.1642     0.8589    0.6961    1.9472
## URBAN_RURALURBAN               1.0880     0.9191    0.6328    1.8707
## beds_grp_c200-399              1.1362     0.8801    0.7144    1.8071
## beds_grp_c400+                 1.4446     0.6922    0.9222    2.2628
## icd_acutekidney                1.1020     0.9074    0.8614    1.4098
## icd_anemia                     1.1207     0.8923    0.7063    1.7782
## icd_HIV                        1.1683     0.8560    0.8557    1.5951
## icd_hypokalemia                0.7088     1.4108    0.5560    0.9038
## icd_hyponatremia               0.9937     1.0063    0.7738    1.2762
## icd_neutropenia                0.5624     1.7781    0.3289    0.9617
## icd_overweight                 1.0730     0.9319    0.7319    1.5732
## icd_transplant                 0.7056     1.4173    0.4663    1.0676
## any_CSFdrain                   0.8238     1.2138    0.5369    1.2643
## med_AMB_any                    1.9823     0.5045    1.1234    3.4982
## med_fluc                       0.2652     3.7703    0.2051    0.3430
## med_5FC                        0.5826     1.7165    0.4128    0.8221
##
## Concordance= 0.771  (se = 0.014 )
## Likelihood ratio test= 115.6  on 27 df,   p=6e-13
## Wald test            = 253.7  on 27 df,   p=<2e-16
## Score (logrank) test = 124.7  on 27 df,   p=2e-14,   Robust = 169.3  p=<2e-16
##
##   (Note: the likelihood ratio and score tests assume independence of
##      observations within a cluster, the Wald and robust score tests do not).
```

##Assessing the PH Assumptions for Covariates

```
# Test (small p means time dependent and needs to be addressed)
# All large --> Met
test.ph <- cox.zph(model4.fit)
test.ph
```

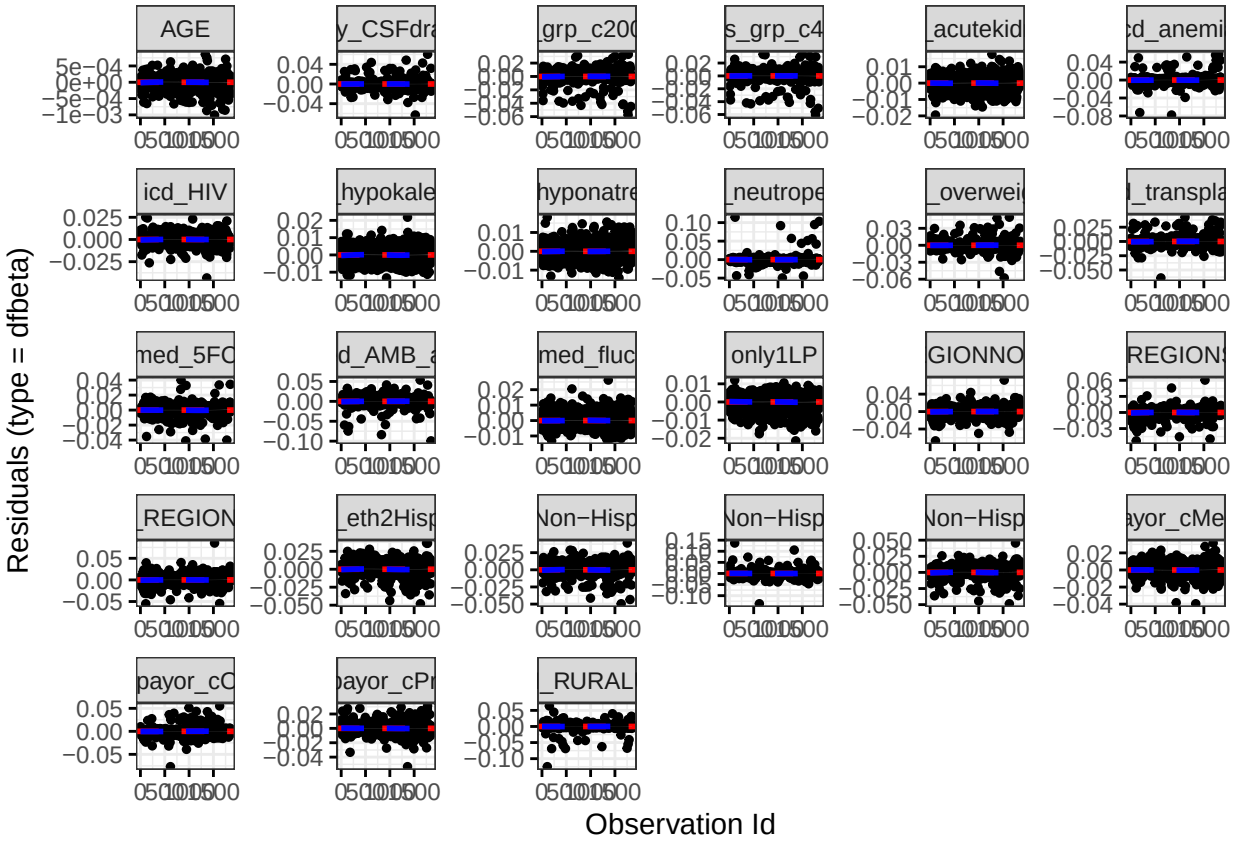
```
##                    chisq df     p
## only1LP           3.9867  1 0.046
## AGE               2.6336  1 0.105
## race_eth2         1.0960  4 0.895
## std_payor_c       5.3119  3 0.150
## PROV_REGION       2.2912  3 0.514
## URBAN_RURAL       0.3217  1 0.571
## beds_grp_c        1.0546  2 0.590
## icd_acutekidney   1.3784  1 0.240
## icd_anemia        0.8450  1 0.358
## icd_HIV           0.8608  1 0.354
## icd_hypokalemia   0.0866  1 0.769
## icd_hyponatremia  0.8707  1 0.351
## icd_neutropenia   0.0404  1 0.841
## icd_overweight    0.0964  1 0.756
## icd_transplant    0.4593  1 0.498
## any_CSFdrain      1.3605  1 0.243
```

```
## med_AMB_any       0.4025  1 0.526
## med_fluc          1.8732  1 0.171
## med_5FC           1.1013  1 0.294
## GLOBAL           19.8803 27 0.836
```

```
# Plots (check to see most points fall on line)
# All look good --> Met
ggcoxdiagnostics(model4.fit, type = "dfbeta",
                 linear.predictions = FALSE, ggtheme = theme_bw())
```

```
## Warning: `gather_()` was deprecated in tidyr 1.2.0.
## i Please use `gather()` instead.
## i The deprecated feature was likely used in the survminer package.
##   Please report the issue at <https://github.com/kassambara/survminer/issues>.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

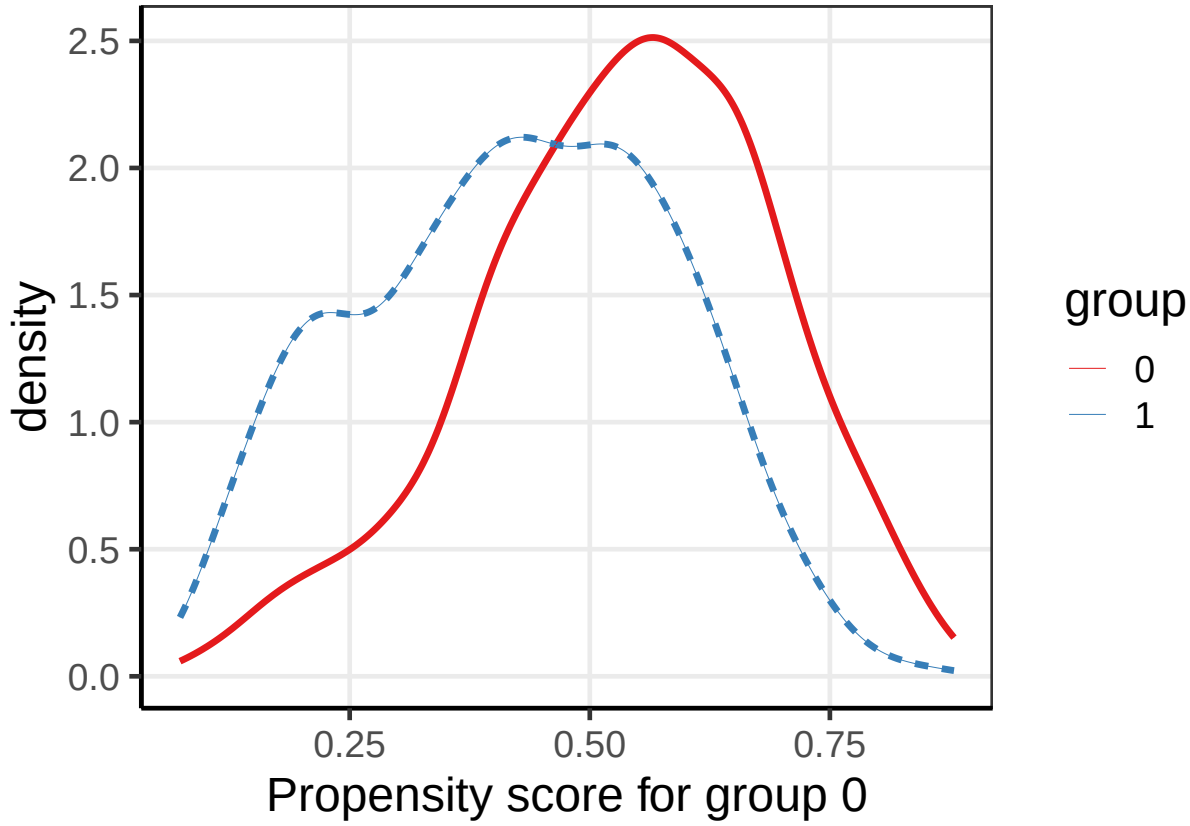



```
# If needed
#ggcoxfunctional(Surv(LOS, died2) ~ AGE + log(AGE) + sqrt(AGE), data = ipw.data)

#NOTE: Are the assumptions met ? --> Yes, Met
```

##Checking Balance of Covariates

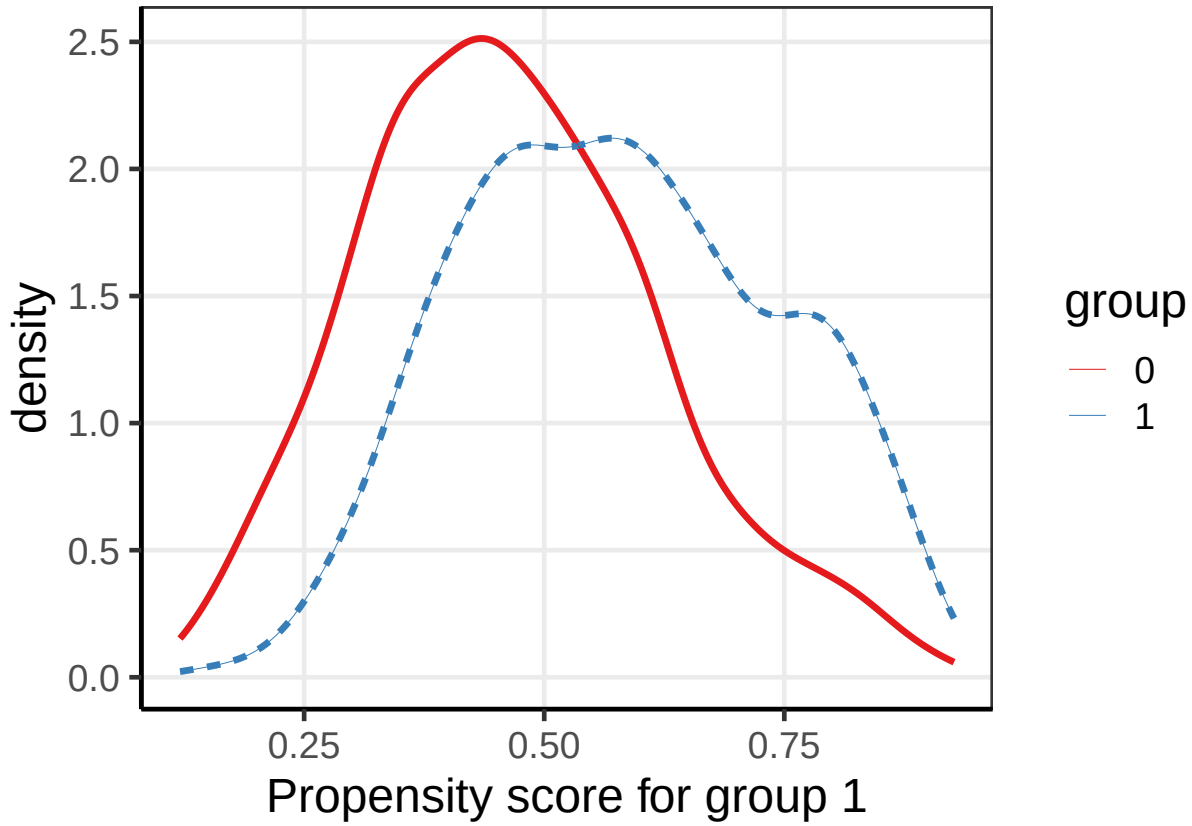
```
# Propensity Weight Formula
ps.mult <- only1LP ~ AGE + race_eth2 + std_payor_c + PROV_REGION + URBAN_RURAL + beds_grp_c +
  icd_acutekidney + icd_anemia+ icd_HIV + icd_hypokalemia + icd_hyponatremia +
  icd_neutropenia + icd_overweight + icd_transplant + any_CSFdrain + med_AMB_any + med_fluc + med_5FC

#Checking Balance for each Weight
propensity <- as.data.frame(propensity)

bal.ipw <- SumStat(ps.formula = ps.mult,
                   weight = c("IPW"), data = propensity)

bal.treat <- SumStat(ps.formula = ps.mult,
                    weight = c("treated"), data = propensity)

bal.over <- SumStat(ps.formula = ps.mult,
                    weight = c("overlap"), data = propensity)

#Balance Plots
plot(bal.ipw, type = "density")
```

```
## Propensity score for group 0
```



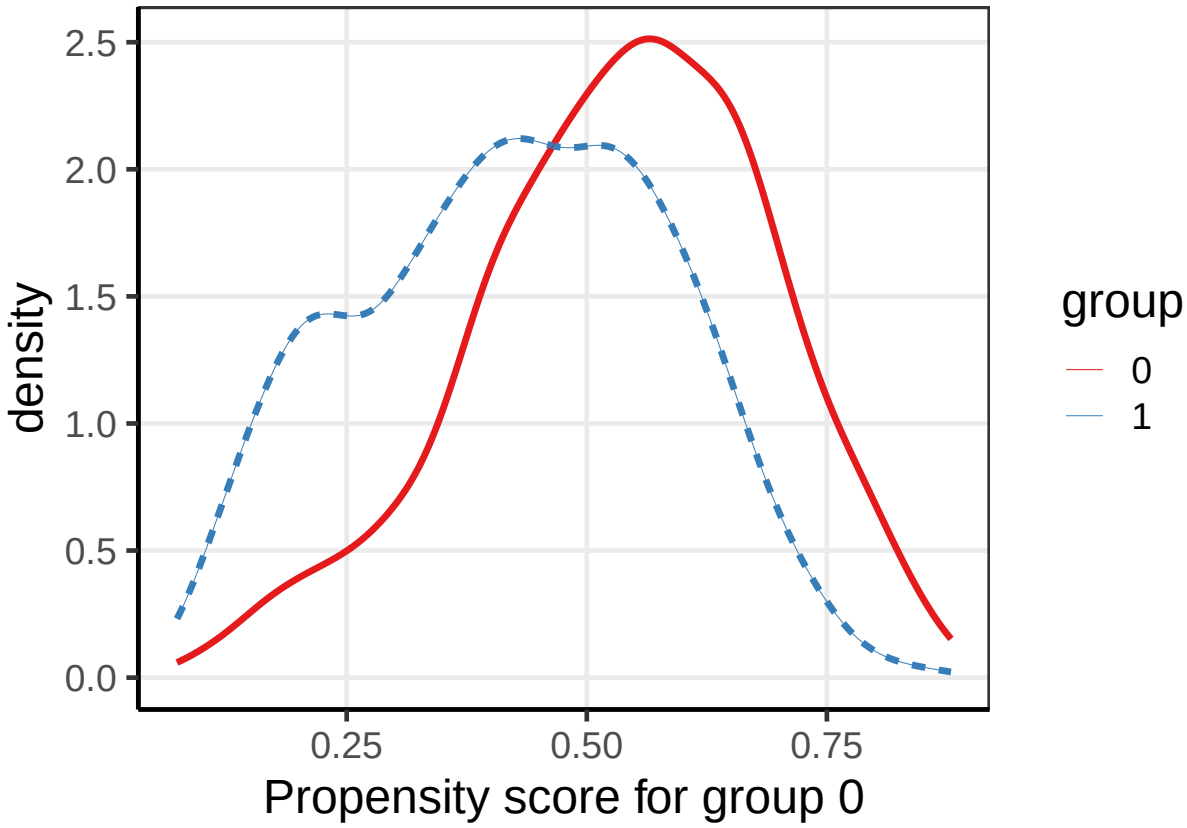

```
## Press [enter] to continue
```

```
## Propensity score for group 1
```



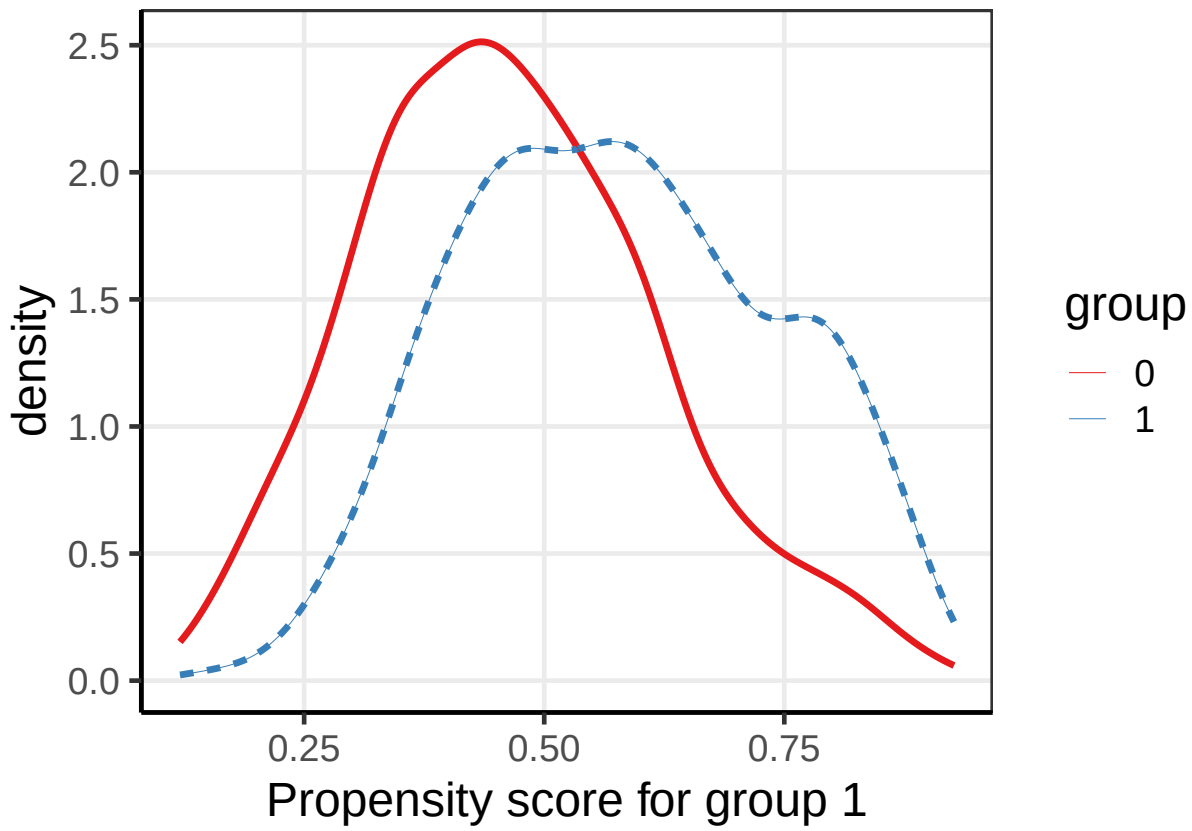

```
plot(bal.treat, type = "density")
```

```
## Propensity score for group 0
```



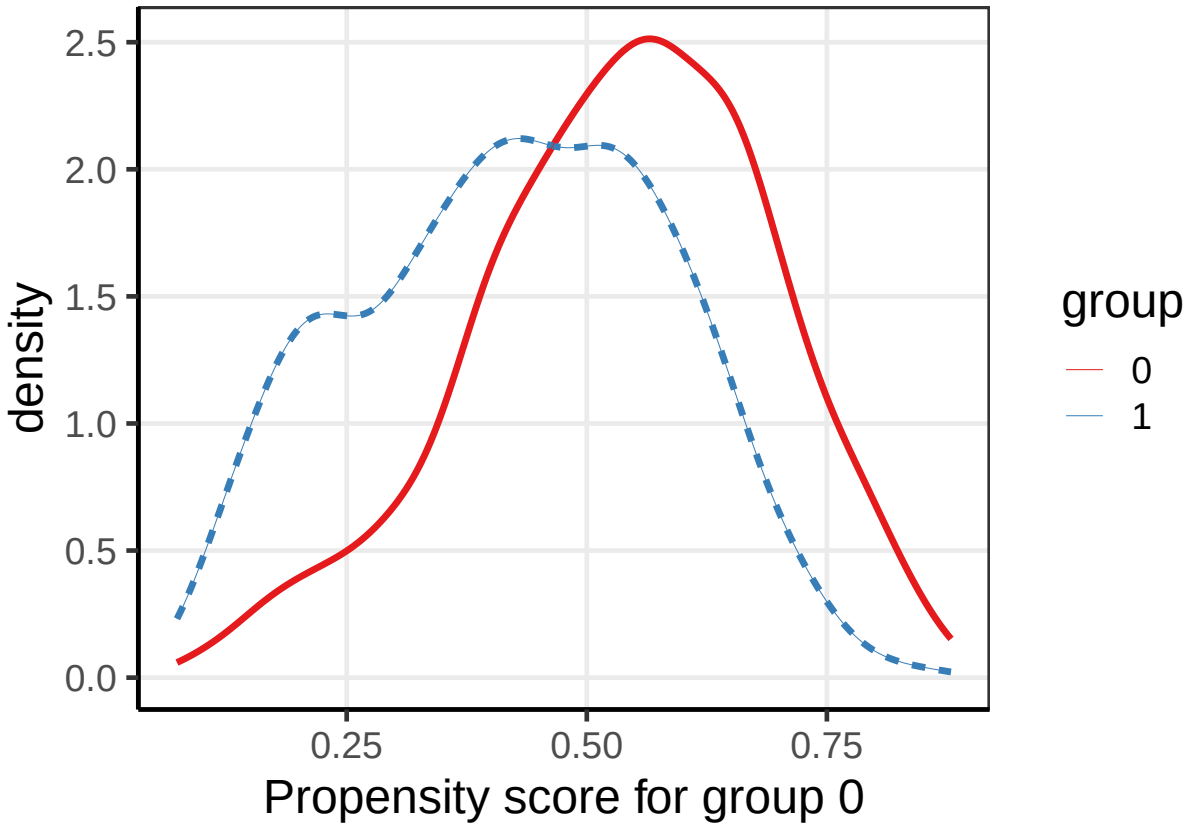

```
## Press [enter] to continue
```

```
## Propensity score for group 1
```



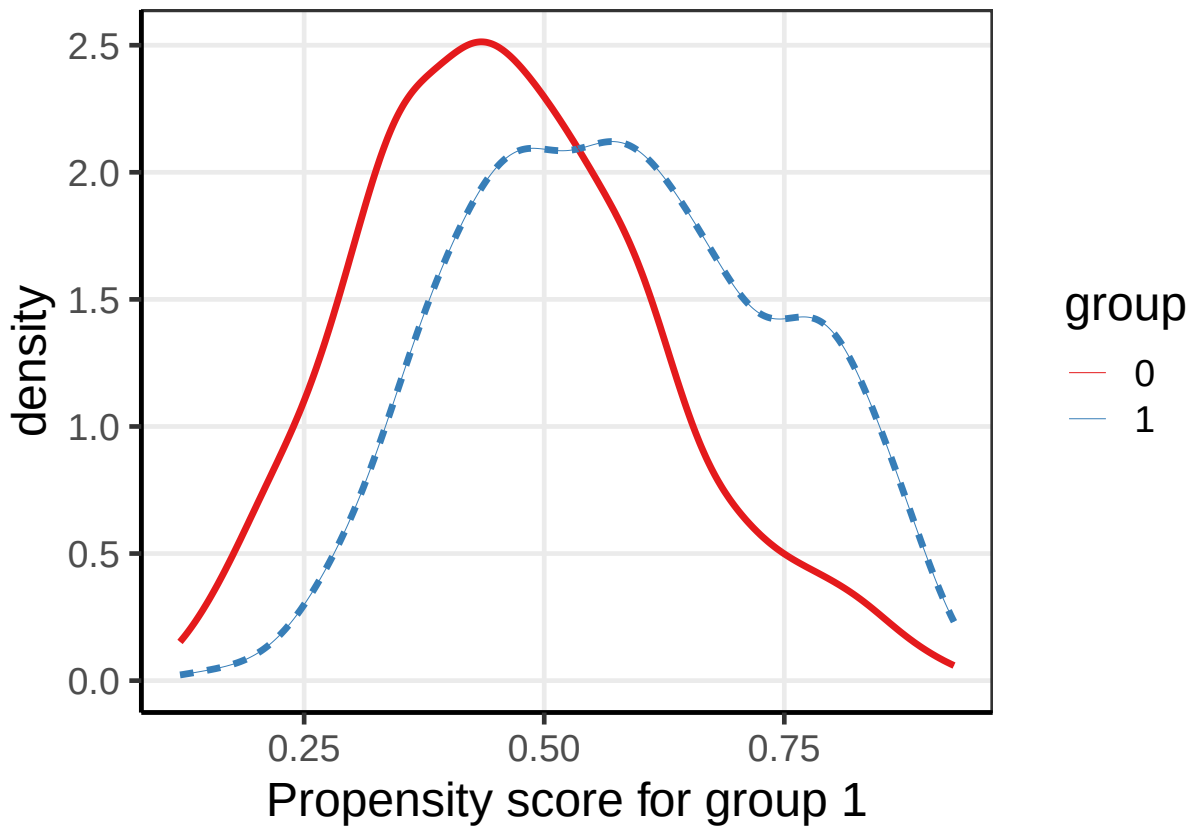

```
plot(bal.over, type = "density")
```

```
## Propensity score for group 0
```

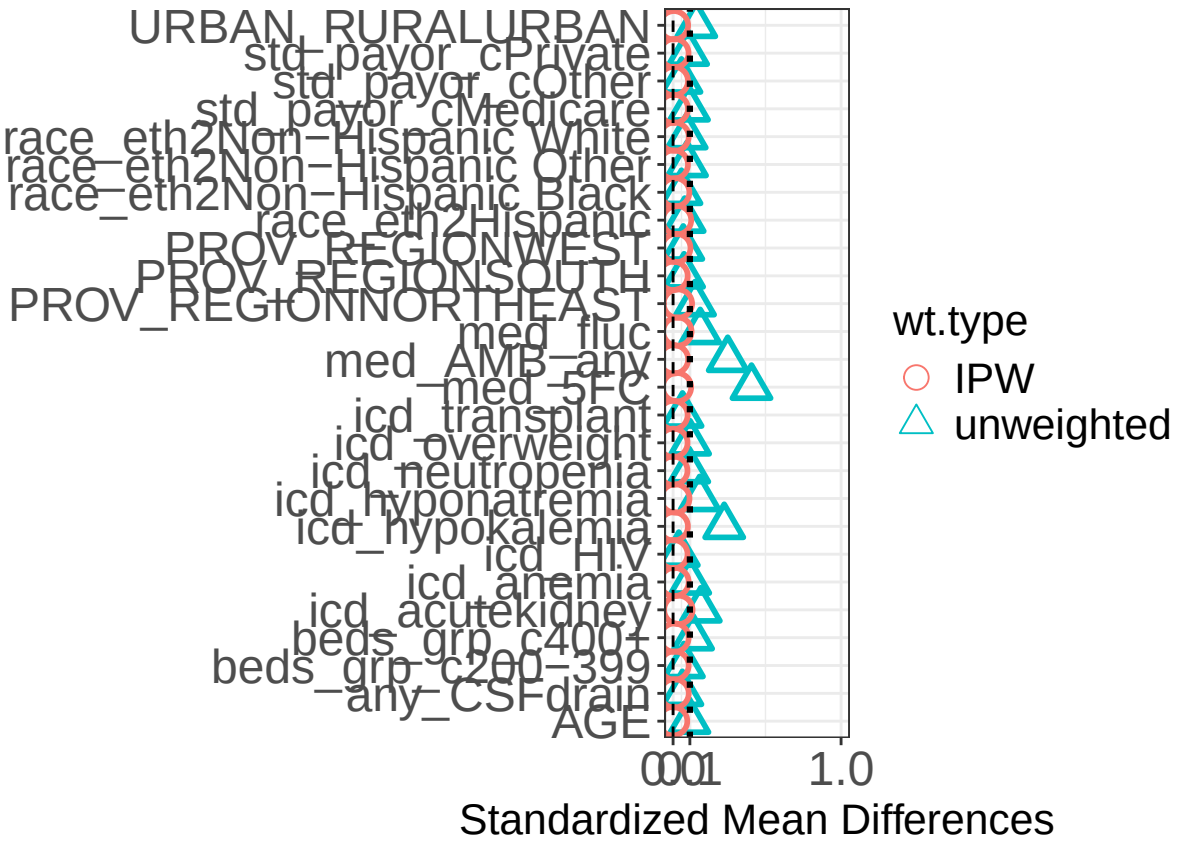



```
## Press [enter] to continue
```

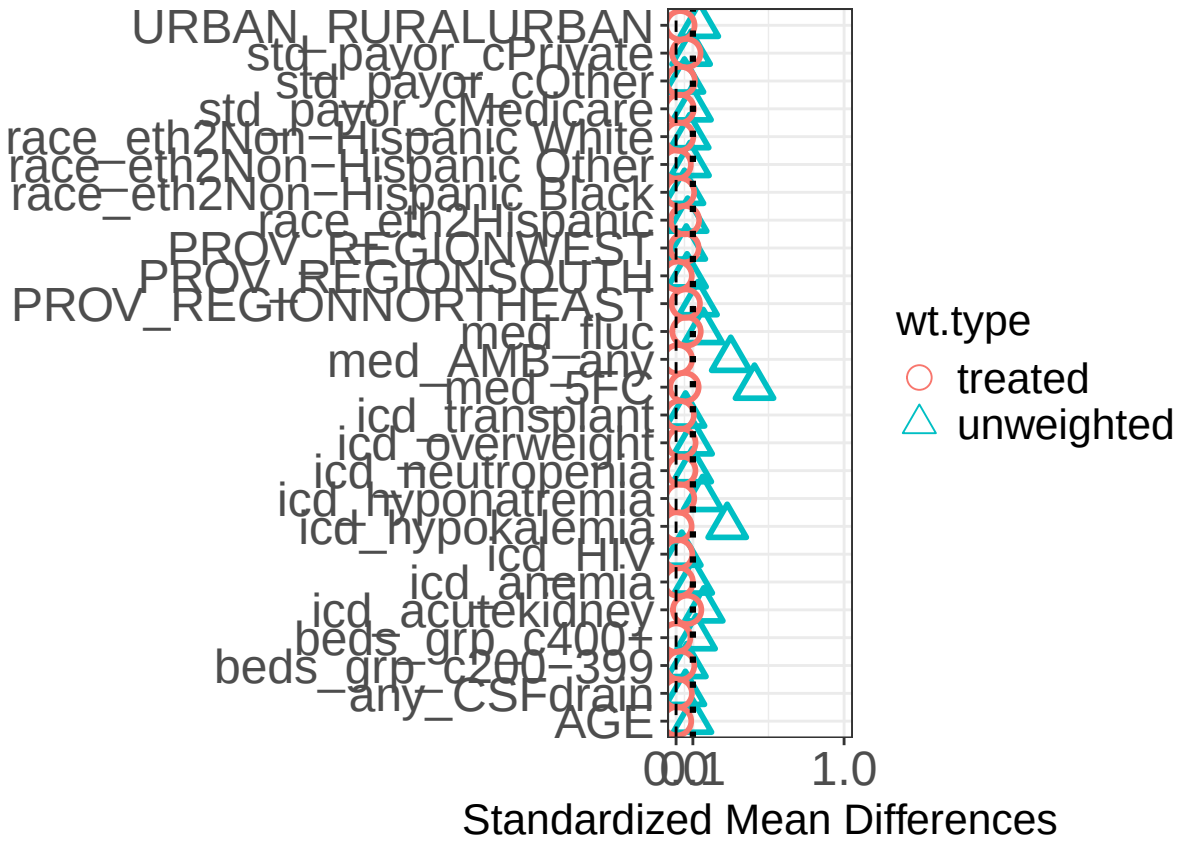
```
## Propensity score for group 1
```



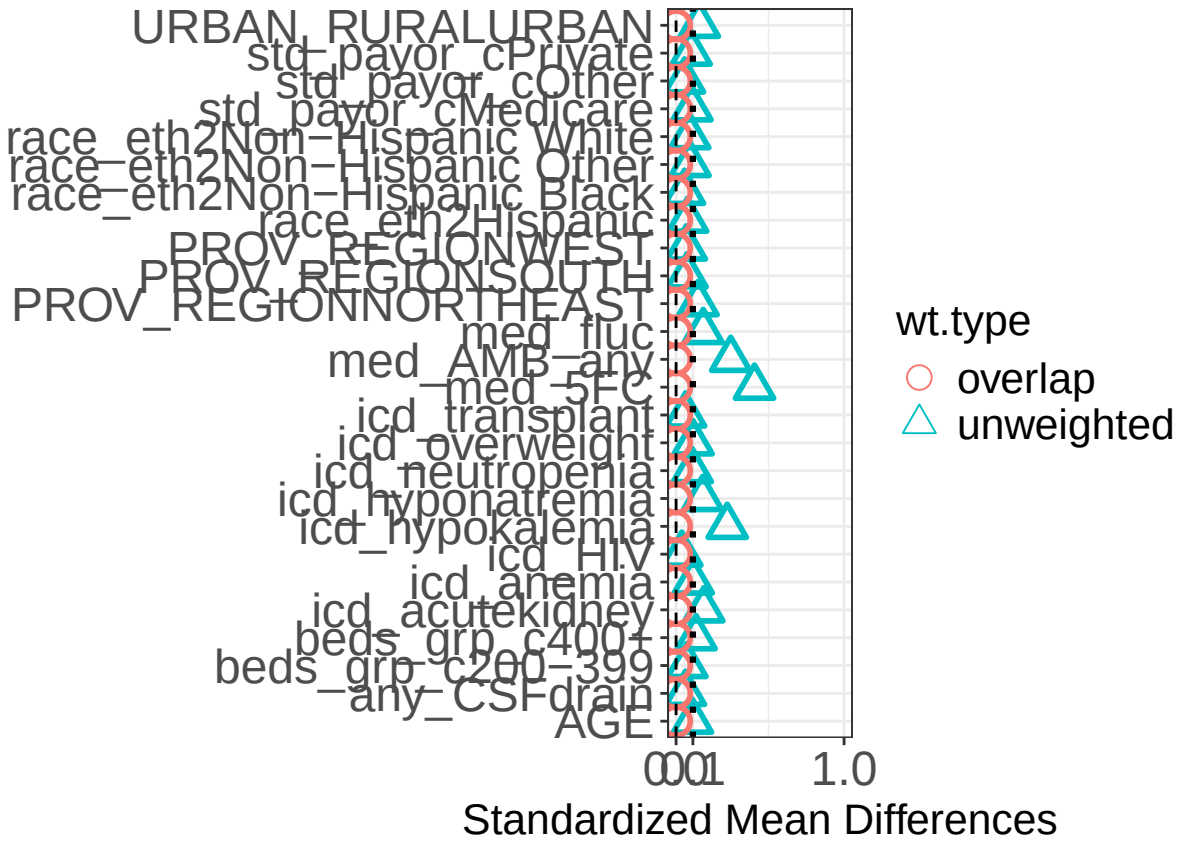

```
# Produce MSD Results
plot(bal.ipw, metric = "ASD")
```




```
plot(bal.treat, metric = "ASD")
```




```
plot(bal.over, metric = "ASD")
```



##Final Estimates Table and Curves

```
# Confidence Limits
ci <- confint.default(model4.fit)
colnames(ci) <- c('UpperCI', 'LowerCI')
ci <- ci[, c(2,1)]

# Exp for estimates and limits for OR and CI
est4 <- exp(cbind(OR = coef(model4.fit),ci))
est4 <- as.data.frame(est4)

# Final Results
summary(model4.fit) #2.67(2.09,3.42) hazard of mortality in 1 LP vs >1 LP
```

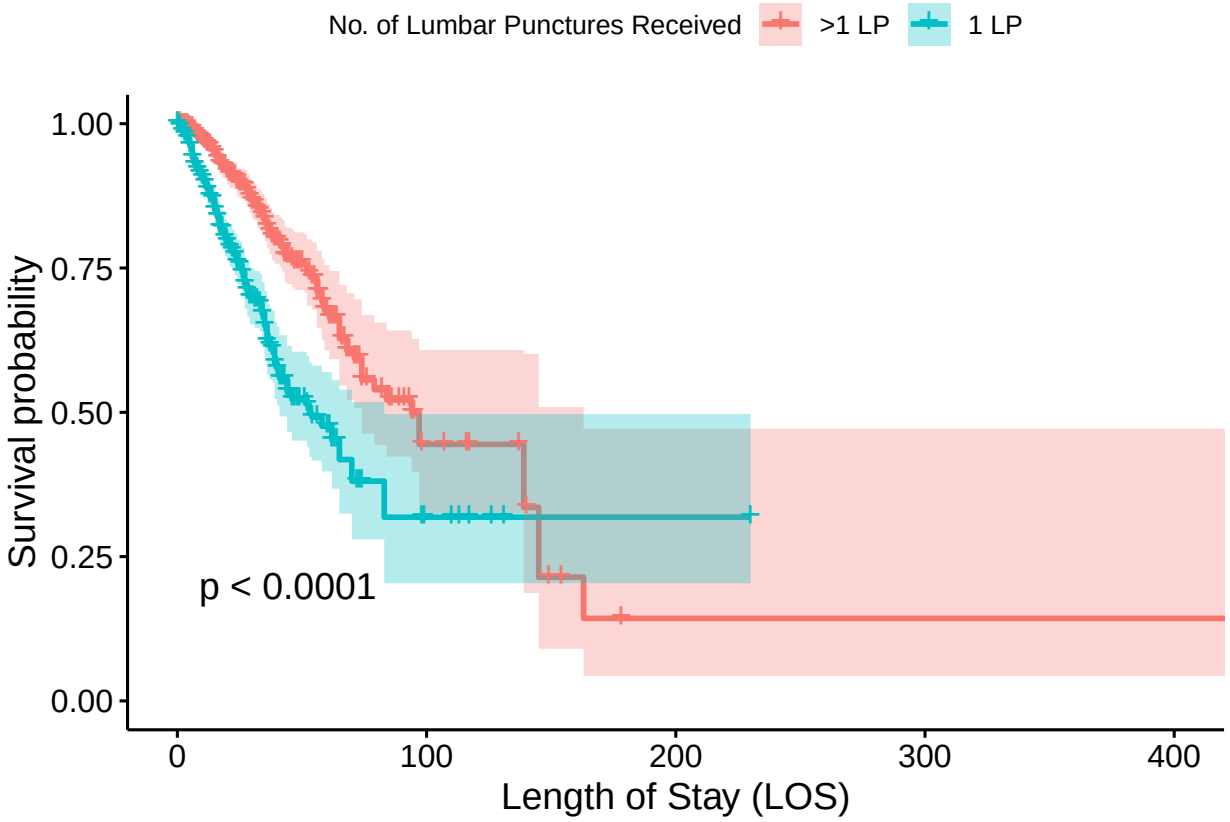
```
## Call:
## coxph(formula = Surv(LOS, died2) ~ only1LP + AGE + race_eth2 +
##     std_payor_c + PROV_REGION + URBAN_RURAL + beds_grp_c + icd_acutekidney +
##     icd_anemia + icd_HIV + icd_hypokalemia + icd_hyponatremia +
##     icd_neutropenia + icd_overweight + icd_transplant + any_CSFdrain +
##     med_AMB_any + med_fluc + med_5FC, data = ipw.data, weights = ov)
##
##   n= 1850, number of events= 328
##
##                                 coef exp(coef)  se(coef) robust se       z
## only1LP                     0.982100  2.670058  0.175794  0.126165   7.784
## AGE                         0.026302  1.026651  0.007961  0.005640   4.663
```

```
## race_eth2Hispanic            0.173876  1.189908  0.313595  0.224174   0.776
## race_eth2Non-Hispanic Black  0.051076  1.052403  0.315450  0.225005   0.227
## race_eth2Non-Hispanic Other -0.258212  0.772432  0.441704  0.350731  -0.736
## race_eth2Non-Hispanic White  0.226923  1.254733  0.292521  0.216685   1.047
## std_payor_cMedicare         -0.039564  0.961208  0.262326  0.191406  -0.207
## std_payor_cOther             0.157776  1.170904  0.315264  0.247234   0.638
## std_payor_cPrivate          -0.233023  0.792135  0.276567  0.198941  -1.171
## PROV_REGIONNORTHEAST        -0.262086  0.769445  0.338594  0.260083  -1.008
## PROV_REGIONSOUTH             0.101003  1.106280  0.273426  0.211770   0.477
## PROV_REGIONWEST              0.152068  1.164239  0.349654  0.262427   0.579
## URBAN_RURALURBAN             0.084350  1.088009  0.383539  0.276521   0.305
## beds_grp_c200-399            0.127729  1.136245  0.348062  0.236726   0.540
## beds_grp_c400+               0.367823  1.444586  0.331257  0.228983   1.606
## icd_acutekidney              0.097135  1.102009  0.178689  0.125672   0.773
## icd_anemia                   0.113947  1.120693  0.341544  0.235553   0.484
## icd_HIV                      0.155538  1.168287  0.213930  0.158879   0.979
## icd_hypokalemia             -0.344126  0.708840  0.173245  0.123953  -2.776
## icd_hyponatremia            -0.006288  0.993732  0.178078  0.127645  -0.049
## icd_neutropenia             -0.575525  0.562409  0.443066  0.273723  -2.103
## icd_overweight               0.070503  1.073048  0.278702  0.195223   0.361
## icd_transplant              -0.348750  0.705570  0.293767  0.211304  -1.650
## any_CSFdrain                -0.193767  0.823850  0.279449  0.218507  -0.887
## med_AMB_any                  0.684277  1.982338  0.418904  0.289781   2.361
## med_fluc                    -1.327147  0.265233  0.183275  0.131217 -10.114
## med_5FC                     -0.540296  0.582576  0.247942  0.175734  -3.075
##                            Pr(>|z|)
## only1LP                    7.01e-15 ***
## AGE                        3.11e-06 ***
## race_eth2Hispanic           0.43797
## race_eth2Non-Hispanic Black  0.82042
## race_eth2Non-Hispanic Other  0.46160
## race_eth2Non-Hispanic White  0.29499
## std_payor_cMedicare         0.83624
## std_payor_cOther            0.52337
## std_payor_cPrivate          0.24147
## PROV_REGIONNORTHEAST        0.31360
## PROV_REGIONSOUTH            0.63340
## PROV_REGIONWEST             0.56227
## URBAN_RURALURBAN            0.76034
## beds_grp_c200-399           0.58950
## beds_grp_c400+              0.10820
## icd_acutekidney             0.43957
## icd_anemia                  0.62857
## icd_HIV                     0.32759
## icd_hypokalemia             0.00550 **
## icd_hyponatremia            0.96071
## icd_neutropenia             0.03550 *
## icd_overweight              0.71799
## icd_transplant              0.09885 .
## any_CSFdrain                0.37520
## med_AMB_any                 0.01821 *
## med_fluc                    < 2e-16 ***
## med_5FC                     0.00211 **
## ---
```

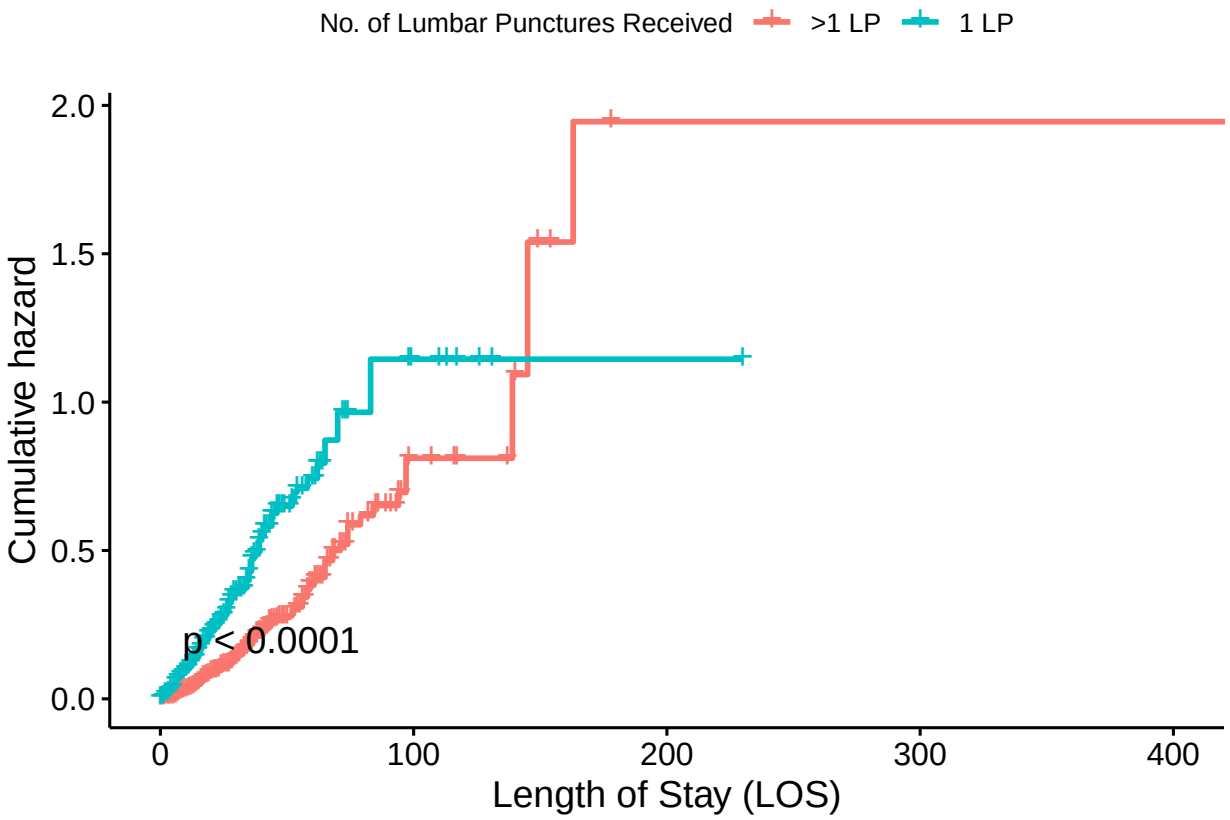
```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##                              exp(coef) exp(-coef) lower .95 upper .95
## only1LP                         2.6701     0.3745    2.0851    3.4191
## AGE                             1.0267     0.9740    1.0154    1.0381
## race_eth2Hispanic               1.1899     0.8404    0.7668    1.8464
## race_eth2Non-Hispanic Black     1.0524     0.9502    0.6771    1.6357
## race_eth2Non-Hispanic Other     0.7724     1.2946    0.3884    1.5360
## race_eth2Non-Hispanic White     1.2547     0.7970    0.8206    1.9186
## std_payor_cMedicare             0.9612     1.0404    0.6605    1.3988
## std_payor_cOther                1.1709     0.8540    0.7212    1.9009
## std_payor_cPrivate              0.7921     1.2624    0.5364    1.1699
## PROV_REGIONNORTHEAST            0.7694     1.2996    0.4622    1.2810
## PROV_REGIONSOUTH                1.1063     0.9039    0.7305    1.6754
## PROV_REGIONWEST                 1.1642     0.8589    0.6961    1.9472
## URBAN_RURALURBAN                1.0880     0.9191    0.6328    1.8707
## beds_grp_c200-399               1.1362     0.8801    0.7144    1.8071
## beds_grp_c400+                  1.4446     0.6922    0.9222    2.2628
## icd_acutekidney                 1.1020     0.9074    0.8614    1.4098
## icd_anemia                      1.1207     0.8923    0.7063    1.7782
## icd_HIV                         1.1683     0.8560    0.8557    1.5951
## icd_hypokalemia                 0.7088     1.4108    0.5560    0.9038
## icd_hyponatremia                0.9937     1.0063    0.7738    1.2762
## icd_neutropenia                 0.5624     1.7781    0.3289    0.9617
## icd_overweight                  1.0730     0.9319    0.7319    1.5732
## icd_transplant                  0.7056     1.4173    0.4663    1.0676
## any_CSFdrain                    0.8238     1.2138    0.5369    1.2643
## med_AMB_any                     1.9823     0.5045    1.1234    3.4982
## med_fluc                        0.2652     3.7703    0.2051    0.3430
## med_5FC                         0.5826     1.7165    0.4128    0.8221
##
## Concordance= 0.771  (se = 0.014 )
## Likelihood ratio test= 115.6  on 27 df,   p=6e-13
## Wald test            = 253.7  on 27 df,   p=<2e-16
## Score (logrank) test = 124.7  on 27 df,   p=2e-14,   Robust = 169.3  p=<2e-16
##
##   (Note: the likelihood ratio and score tests assume independence of
##      observations within a cluster, the Wald and robust score tests do not).
```

```
# for LOS <= 150: HR = 2.68 (2.09, 3.43)
# for LOS <= 138: HR = 2.64 (2.06, 3.38)



# Fit Survival Curves
fit<- survfit(Surv(LOS, died2) ~ only1LP, weights = ov, data = ipw.data)

# Plot survival curves (PDF)
ggsurvplot(fit, data = ipw.data,
legend.title = "No. of Lumbar Punctures Received",
legend.labs = c(">1 LP", "1 LP"),
xlab = "Length of Stay (LOS)",
pval = TRUE,
conf.int = TRUE
```

```
)
```




```
# Plot Log Cumulative Hazard Function
ggsurvplot(fit,
           fun = "cumhaz",
           data = ipw.data,
           legend.title = "No. of Lumbar Punctures Received",
           legend.labs = c(">1 LP", "1 LP"),
           xlab = "Length of Stay (LOS)",
           pval = TRUE,

)
```


No. of Lumbar Punctures Received
>1 LP
1 LP
Cumulative hazard
2.0
1.5
1.0
0.5
0.0
p < 0.0001
0
100
200
300
400
Length of Stay (LOS)