PHP2517 Final Project

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Introduction

According to [1], chronic diseases are severe conditions that can get worse over time. Their controllable but not curable feature pose significant challenges to public health systems [1]. Common conditions, including "cancer, heart disease, stroke, diabetes, and arthritis," not only lead to prolonged illness but also contribute substantially to the economic burden faced by societies [1]. Traditional epidemiological studies utilize simple statistical models that might not account for the complexity of state-level and region-level determinants of health. As a result, there is a pressing need for more sophisticated analytical approaches to provide a deeper understanding of the factors influencing chronic disease mortality.

Multilevel modeling (MLM), or hierarchical linear modeling, offers a robust statistical framework for analyzing data structures at multiple levels. This approach is particularly suitable for public health research, where data often involve nested structures, such as patients within hospitals. MLM allows researchers to explore the impact of different level predictors and how these effects vary across groups. This study aims to employ multilevel models to analyze chronic disease mortality data, focusing on identifying critical state-level and region-level predictors. By integrating multiple levels of data, this research seeks to uncover potential targets for intervention that could mitigate the risk factors associated with chronic diseases.

Data Source

Our data come from the Dartmouth Atlas Project [2]. This site offers access to decades of Medicare data and supplemental materials. Our data are from 2019 and initially have 68 covariates. In terms of data preprocessing, we first look through all variables and try to identify variables with similar meanings. To the best of our knowledge, we only keep variables that have distinct meanings and remove other variables with duplicated information. For example, when we retain variables of `Ratio to the U.S. Average`, we remove the corresponding variables that record the actual numbers. After we choose the `Total` variables, we drop the other variables related to sub-categories. In addition, we remove the `System` variable due to a large proportion (20%) of missing values in in its column. There is an error with the variable `Hospice Days per Decedent during the Last Six Months of Life`, it is more likely to refer to reimbursements than days (data summary has a mean = 1091, min = 1, max = 2180, similar to summaries of other reimbursement variables). So we drop this variable as well. The last step of data cleaning is removing rows with NA values. The final dataset involves 2174 observations and 32 variables: 2 categorical variables are State and Region, and the rest are all numeric. Our outcome in this project is "Number of deaths among chronically ill patients assigned to hospital." We are concerned about the predictability of both longer-term (two years) and the shorter-term (six months) variables on our outcome of interest.

Pre-Proccessing of Data

First of all, to better analyze the pattern of the data, we would like to add a column of `Region` based on the `State` column. We divide the states into four regions: Northeast, Midwest, South, and West. We then check the missing values in the dataset.

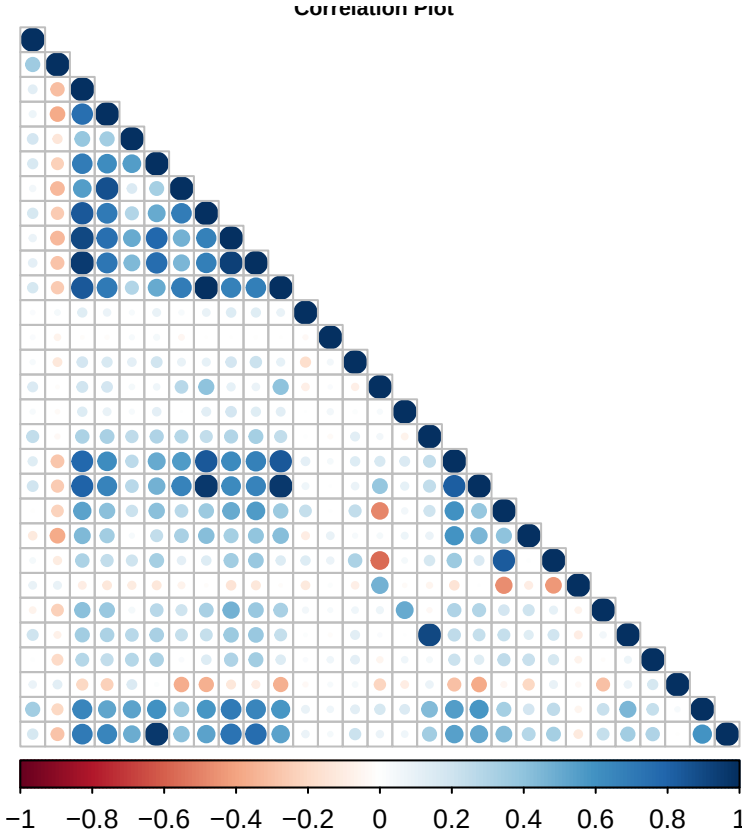
Then, we tried to find the columns with missing values and the ratio of missing values in these columns. We found that the `System` column has 20% missing values, and the `Ambulance spending per Decedent`

during the last two years of life column has 0.4% missing values. We decided to remove the System column and remove the rows with missing values in the Ambulance spending per Decedent during the last two years of life column. Furthermore, from the description of the dataset, we know that there are some columns use negative values to represent missing values. We will replace these negative values with NA. Finally, we will remove the rows with NA values and check the proportion of zeros in each column.

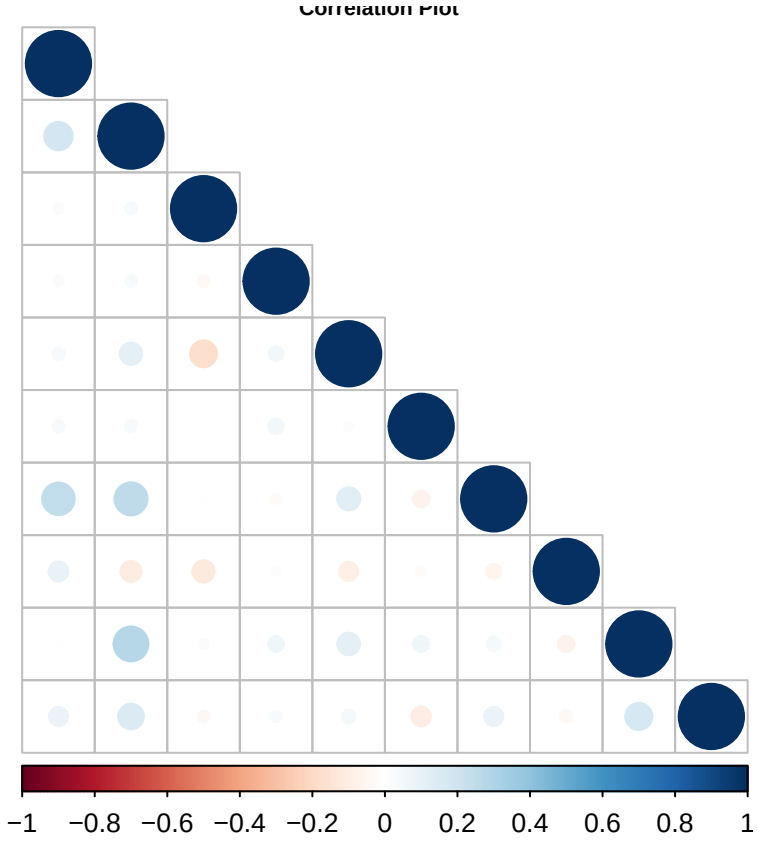
To be noticed that, we did find a lot of variables in the dataset seems to be overlapping with each other. For example, Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life and High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life are tow sets that share the same subset which is High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life, we will remove the High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life column.

After a detailed examination of the dataset, we will remove these variables: HRR, HRR Name, Provider ID, City, Inpatient Sector Reimbursements per Decedent during the Last Two Years of Life, Outpatient Sector Reimbursements per Decedent during the Last Two Years of Life, SNF/Long-Term Care Sector Reimbursements per Decedent during the Last Two Years of Life, Home Health Sector Reimbursements per Decedent during the Last Two Years of Life, Hospice Sector Reimbursements per Decedent during the Last Two Years of Life, Reimbursements for Durable Medical Equipment per Decedent during the Last Two Years of Life, Ambulance spending per Decedent during the last two years of life, Part B Spending for Evaluation & Management per Decedent during the Last Two Years of Life,Part B Spending for Procedures per Decedent during the Last Two Years of Life, Part B Spending for Imaging per Decedent during the Last Two Years of Life, Part B Spending for Tests per Decedent during the Last Two Years of Life, Other Part B spending per Decedent during the last two years of life, Inpatient Days per Decedent during the Last Two Years of Life, Reimbursements per patient day (calculated), Reimbursements per Day: Ratio to US Average (calculated), Hospital reimbursements per Decedent during the last two years of life, Payments per physician visit (calculated), Payments for physician visits per Decedent during the last two years of life, Physician Visits per Decedent during the Last Two Years of Life, Payments per visit: Ratio to US Average (calculated), FTE Physician Labor Inputs per 1,000 Decedents during the Last Two Years of Life, FTE Medical Specialist Labor Inputs per 1,000 Decedents during the Last Two Years of Life, FTE Primary Care Physician Labor Inputs per 1,000 Decedents during the Last Two Years of Life, Average Co-Payments for Physician Services per Decedent during the Last Two Years of Life, Average Co-Payments for Durable Medical Equipment per Decedent during the Last Two Years of Life, Percent of Deaths Occurring In Hospital, Percent of Deaths Associated With ICU Admission, Physician Visits per Decedent during the Last Six Months of Life, Medical Specialist Visits per Decedent during the Last Six Months of Life, Primary Care Visits per Decedent during the Last Six Months of Life and Percent of Decedents Seeing 10 or More Different Physicians during the Last Six Months of Life.

Now, let's examine the corelation between the numeric variables in the dataset. A correlation plot can help us to identify the highly correlated variables.



Although we have manually filtered out a lot of overlapping variables in the previous step, we can see that there are many highly correlated variables in the dataset. This is probably due to those variables has causal effects with each other, and if we include all of them in the model, it will cause problems. We will remove the highly correlated variables using a threshold of 0.3.



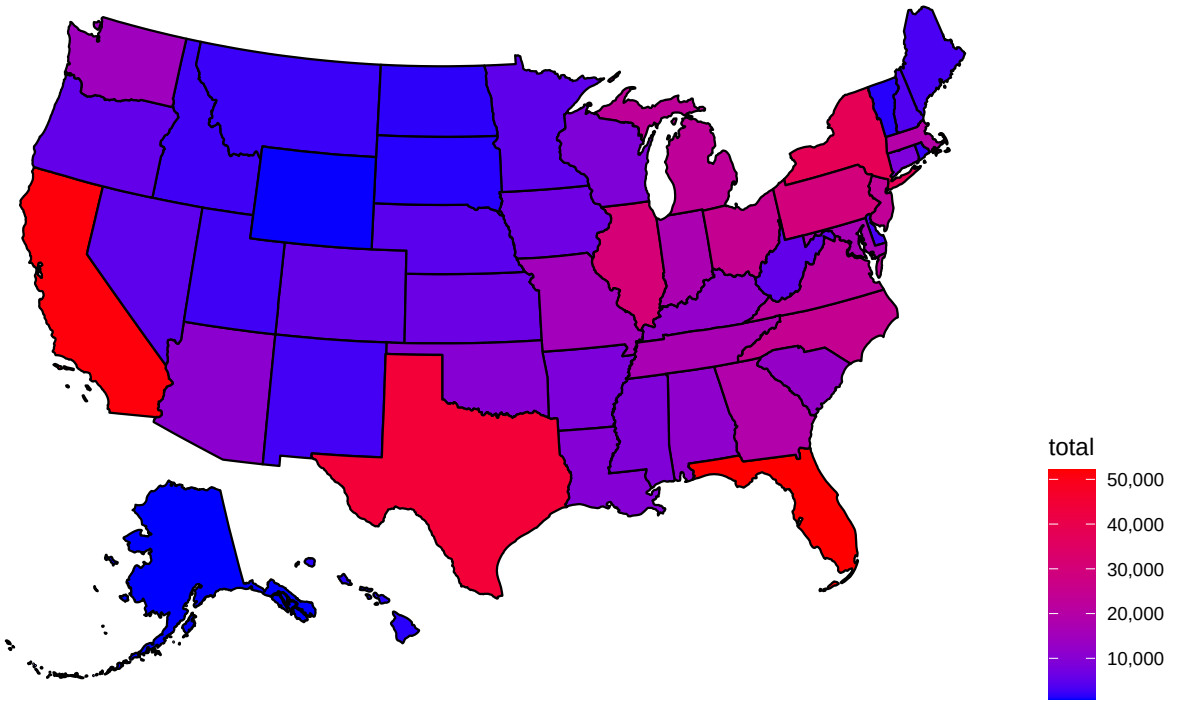

```
##  [1] "Hospital Name"
##  [2] "State"
##  [3] "Region"
##  [4] "Number of deaths among chronically ill patients assigned to hospital"
##  [5] "Other spending per Decedent during the last two years of life"
##  [6] "Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life"
##  [7] "High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life"
##  [8] "Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life"
##  [9] "SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life"
## [10] "Standardized FTE physician labor: Ratio MS/PC (calculated)"
## [11] "Medical & Surgical Unit Days per Decedent during the Last Six Months of Life"
## [12] "Home Health Agency Visits per Decedent during the Last Six Months of Life"
## [13] "Percent of Decedents Enrolled In Hospice during the Last Six Months of Life"
```

Most of the variables that are highly correlated with each other have been removed. There are 13 variables left in the dataset.

Exploratory Data Analysis

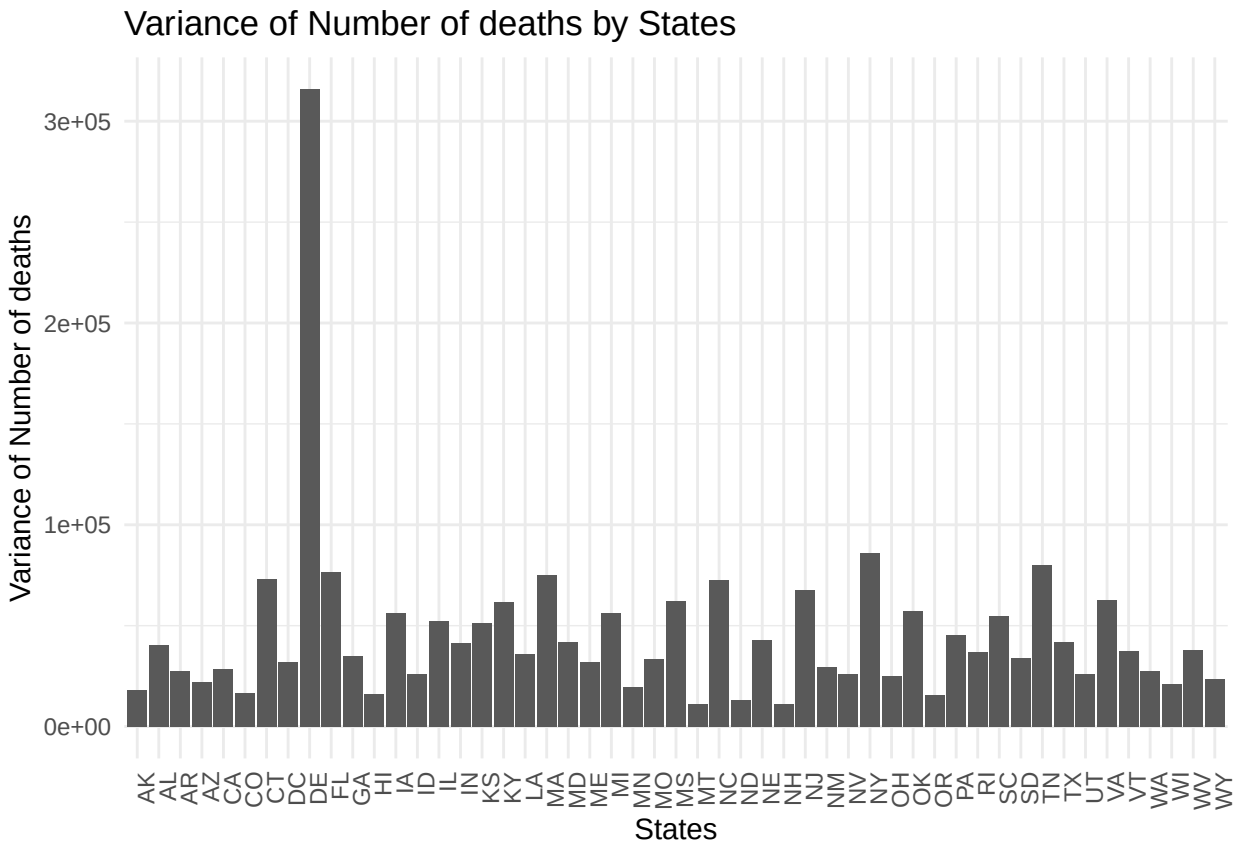
We will start by checking the map of the United States to see the distribution of the data. We will use the `ggplot2` package to plot the map of the United States and color the states based on the number of deaths among chronically ill patients assigned to hospital.

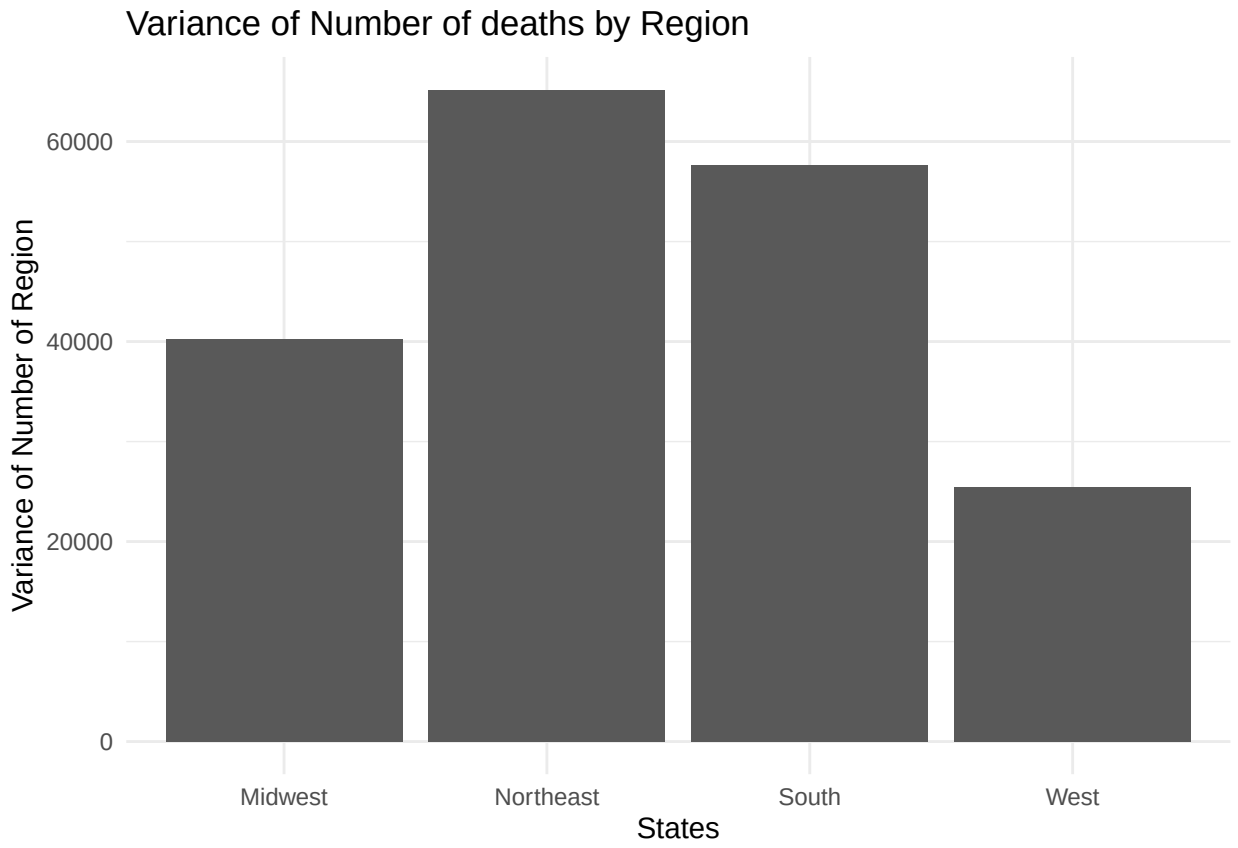
Total Chronic Deaths by State



To make the data more clear, we also provide a table of the summary of the number of deaths by region and state.

We might also want to see the variance of the number of deaths by states and regions.


Variance of Number of deaths by States
Variance of Number of deaths
3e+05
2e+05
1e+05
0e+00
AK AL AR AZ CA CO CT DC DE FL GA HI IA ID IL IN KS KY LA MA MD ME MI MN MO MS MT NC ND NE NH NJ NM NV NY OH OK OR PA RI SC SD TN TX UT VA VT WA WI WV WY
States


Variance of Number of deaths by Region
Variance of Number of Region
60000
40000
20000
0
Midwest
Northeast
South
West
States

We do find that the total number of deaths varies significantly across states and regions. This suggests that there might be some state-level and region-level predictors that can explain the variance in the number of deaths among chronically ill patients assigned to hospital. Now, we would like to see if the predictors in the dataset are significantly different across regions and states.

The following table shows the summary of the variables by region. We can see that the variables are significantly different across regions.

And this table shows the summary of the variables by state. We can see that the variables are significantly different across states.

Based on the exploratory data analysis, we find that the number of deaths among chronically ill patients assigned to hospital varies significantly across states and regions. This suggests that a multilevel model might be more appropriate for analyzing the data. In the next section, we will use generalized linear models (GLM) to do the variable selection and then fit a multilevel model to the data. Our multilevel model will include two levels: state-level and hospital-level. We will use the `lmer` function to fit the multilevel model and use the `anova` test to compare the models with and without random effects to determine the best model.

With regards to the multilevel structure of the data, level 1 refers to the State, and level 2 is the Region (we manually convert states to four regions: Midwest, Southeast, South, and West). After constructing models, we compare their AIC values to determine the better model.

$Y_{ij} \sim N(\beta_j, \sigma^2), \beta_j \sim N(\mu, \tau^2)$

- Summary table

```
##  Groups   Name        Std.Dev.
##  State    (Intercept)  33.918
##  Residual             220.123
```

```
##             Estimate Std. Error       df  t value     Pr(>|t|)
## (Intercept) 317.9421   7.486034 41.13281 42.47137 1.334635e-35
```

- Summary table

```
##  Groups   Name        Std.Dev.
##  Region   (Intercept)  31.535
##  Residual             221.334
```

```
##             Estimate Std. Error       df  t value     Pr(>|t|)
## (Intercept) 317.6594   16.57594 2.902643 19.16388 0.0003792429
```

```
##    df      AIC
## m1  3 28180.84
## m2  3 28181.62
```

Because m1 has a slightly lower AIC value, m1 is the better model. Intercept variance = $(35.544)^2 = 1263.376$ represents how much variance in outcome (number of deaths) that is explained between states. Residual variance = $(219.670)^2 = 48254.91$ represents the within state unexplained variance. $\beta_0 + b_{0j} = 305.5872 + b_{0j}$ represents the estimated number of deaths (individual intercept) for the jth state.

Variable Selection through GLM

We will start by using generalized linear models (GLM) to analyze the data. This step is mainly used to do the variable selection, and we will conduct a backward selection on the model to find out the variable that have the greatest influence on the outcome.

We start with the full model, which includes `State`, `Other spending per Decedent during the last two years of life`, `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`, `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`,

Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life, SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life, Standardized FTE physician labor: Ratio MS/PC (calculated), Medical & Surgical Unit Days per Decedent during the Last Six Months of Life, Home Health Agency Visits per Decedent during the Last Six Months of Life, and Percent of Decedents Enrolled In Hospice during the Last Six Months of Life as predictors. Number of deaths among chronically ill patients assigned to hospital is the outcome variable.

```
##
## Call:
## glm(formula = `Number of deaths among chronically ill patients assigned to hospital` ~
##     State + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life
##         `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`,
##     data = df.chronic)
##
## Coefficients:
##                                                                                    Esti
## (Intercept)                                                                      -2.208
## StateAL                                                                           2.620
## StateAR                                                                           2.461
## StateAZ                                                                           1.193
## StateCA                                                                           1.798
## StateCO                                                                           8.823
## StateCT                                                                           2.894
## StateDC                                                                           2.381
## StateDE                                                                           3.691
## StateFL                                                                           2.045
## StateGA                                                                           1.809
## StateHI                                                                           1.104
## StateIA                                                                           1.728
## StateID                                                                           2.306
## StateIL                                                                           1.890
## StateIN                                                                           1.778
## StateKS                                                                           1.859
## StateKY                                                                           2.332
## StateLA                                                                           2.455
## StateMA                                                                           3.046
## StateMD                                                                           2.796
## StateME                                                                           9.793
## StateMI                                                                           2.497
## StateMN                                                                           1.450
## StateMO                                                                           1.846
## StateMS                                                                           2.815
## StateMT                                                                           1.939
## StateNC                                                                           2.377
## StateND                                                                           1.369
## StateNE                                                                           1.459
```

```
## StateNH                                                                                                 2.020e
## StateNJ                                                                                                 2.080e
## StateNM                                                                                                 1.987e
## StateNV                                                                                                 1.754e
## StateNY                                                                                                 2.848e
## StateOH                                                                                                 1.509e
## StateOK                                                                                                 2.590e
## StateOR                                                                                                 1.582e
## StatePA                                                                                                 1.975e
## StateRI                                                                                                 1.553e
## StateSC                                                                                                 2.506e
## StateSD                                                                                                 2.454e
## StateTN                                                                                                 2.942e
## StateTX                                                                                                 1.933e
## StateUT                                                                                                 2.198e
## StateVA                                                                                                 2.756e
## StateVT                                                                                                 3.107e
## StateWA                                                                                                 2.252e
## StateWI                                                                                                 8.221e
## StateWV                                                                                                 2.458e
## StateWY                                                                                                 1.895e
## `Other spending per Decedent during the last two years of life`                                         9.671e
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`                            2.060e
## `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`                   7.410e
## `Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`           1.177e
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`                                  1.289e
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                                            1.254e
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`                          4.402e
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`                            -5.565e
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`                           4.267e
##                                                                                                      Std. E
## (Intercept)                                                                                             1.088e
## StateAL                                                                                                 1.119e
## StateAR                                                                                                 1.139e
## StateAZ                                                                                                 1.117e
## StateCA                                                                                                 1.065e
## StateCO                                                                                                 1.140e
## StateCT                                                                                                 1.150e
## StateDC                                                                                                 1.405e
## StateDE                                                                                                 1.360e
## StateFL                                                                                                 1.086e
## StateGA                                                                                                 1.093e
## StateHI                                                                                                 1.283e
## StateIA                                                                                                 1.157e
## StateID                                                                                                 1.269e
## StateIL                                                                                                 1.080e
## StateIN                                                                                                 1.094e
## StateKS                                                                                                 1.157e
## StateKY                                                                                                 1.110e
## StateLA                                                                                                 1.130e
## StateMA                                                                                                 1.101e
## StateMD                                                                                                 1.105e
## StateME                                                                                                 1.197e
## StateMI                                                                                                 1.091e
```

```
## StateMN                                                                        1.151
## StateMO                                                                        1.097
## StateMS                                                                        1.135
## StateMT                                                                        1.265
## StateNC                                                                        1.087
## StateND                                                                        1.352
## StateNE                                                                        1.176
## StateNH                                                                        1.207
## StateNJ                                                                        1.090
## StateNM                                                                        1.217
## StateNV                                                                        1.175
## StateNY                                                                        1.073
## StateOH                                                                        1.089
## StateOK                                                                        1.127
## StateOR                                                                        1.142
## StatePA                                                                        1.078
## StateRI                                                                        1.299
## StateSC                                                                        1.118
## StateSD                                                                        1.482
## StateTN                                                                        1.106
## StateTX                                                                        1.082
## StateUT                                                                        1.282
## StateVA                                                                        1.091
## StateVT                                                                        1.416
## StateWA                                                                        1.096
## StateWI                                                                        1.110
## StateWV                                                                        1.158
## StateWY                                                                        1.488
## `Other spending per Decedent during the last two years of life`                1.723
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   7.889
## `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  7.438
## `Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  8.118
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`         8.492
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   1.193
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  7.706
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    1.567
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  9.734
##                                                                              t valu
## (Intercept)                                                                   -2.02
## StateAL                                                                        2.34
## StateAR                                                                        2.16
## StateAZ                                                                        1.06
## StateCA                                                                        1.68
## StateCO                                                                        0.77
## StateCT                                                                        2.51
## StateDC                                                                        1.69
## StateDE                                                                        2.71
## StateFL                                                                        1.88
## StateGA                                                                        1.65
## StateHI                                                                        0.86
## StateIA                                                                        1.49
## StateID                                                                        1.81
## StateIL                                                                        1.75
## StateIN                                                                        1.62
```

```
## StateKS                                                                        1.60
## StateKY                                                                        2.10
## StateLA                                                                        2.17
## StateMA                                                                        2.76
## StateMD                                                                        2.53
## StateME                                                                        0.81
## StateMI                                                                        2.28
## StateMN                                                                        1.25
## StateMO                                                                        1.68
## StateMS                                                                        2.48
## StateMT                                                                        1.53
## StateNC                                                                        2.18
## StateND                                                                        1.01
## StateNE                                                                        1.24
## StateNH                                                                        1.67
## StateNJ                                                                        1.90
## StateNM                                                                        1.63
## StateNV                                                                        1.49
## StateNY                                                                        2.65
## StateOH                                                                        1.38
## StateOK                                                                        2.29
## StateOR                                                                        1.38
## StatePA                                                                        1.83
## StateRI                                                                        1.19
## StateSC                                                                        2.24
## StateSD                                                                        1.65
## StateTN                                                                        2.66
## StateTX                                                                        1.78
## StateUT                                                                        1.71
## StateVA                                                                        2.52
## StateVT                                                                        2.19
## StateWA                                                                        2.05
## StateWI                                                                        0.74
## StateWV                                                                        2.12
## StateWY                                                                        1.27
## `Other spending per Decedent during the last two years of life`                5.61
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   2.61
## `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   0.99
## `Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   1.44
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`         1.51
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                  10.51
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`   5.71
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`   -3.55
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   4.38
##                                                                              Pr(>|t
## (Intercept)                                                                  0.0425
## StateAL                                                                      0.0192
## StateAR                                                                      0.0307
## StateAZ                                                                      0.2855
## StateCA                                                                      0.0914
## StateCO                                                                      0.4390
## StateCT                                                                      0.0119
## StateDC                                                                      0.0903
## StateDE                                                                      0.0067
```

```
## StateFL                                                                                0.0596
## StateGA                                                                                0.0978
## StateHI                                                                                0.3896
## StateIA                                                                                0.1354
## StateID                                                                                0.0692
## StateIL                                                                                0.0802
## StateIN                                                                                0.1042
## StateKS                                                                                0.1083
## StateKY                                                                                0.0357
## StateLA                                                                                0.0299
## StateMA                                                                                0.0057
## StateMD                                                                                0.0114
## StateME                                                                                0.4133
## StateMI                                                                                0.0222
## StateMN                                                                                0.2080
## StateMO                                                                                0.0926
## StateMS                                                                                0.0131
## StateMT                                                                                0.1254
## StateNC                                                                                0.0288
## StateND                                                                                0.3112
## StateNE                                                                                0.2147
## StateNH                                                                                0.0943
## StateNJ                                                                                0.0563
## StateNM                                                                                0.1026
## StateNV                                                                                0.1355
## StateNY                                                                                0.0079
## StateOH                                                                                0.1660
## StateOK                                                                                0.0216
## StateOR                                                                                0.1661
## StatePA                                                                                0.0671
## StateRI                                                                                0.2319
## StateSC                                                                                0.0251
## StateSD                                                                                0.0978
## StateTN                                                                                0.0078
## StateTX                                                                                0.0740
## StateUT                                                                                0.0865
## StateVA                                                                                0.0116
## StateVT                                                                                0.0283
## StateWA                                                                                0.0400
## StateWI                                                                                0.4591
## StateWV                                                                                0.0339
## StateWY                                                                                0.2030
## `Other spending per Decedent during the last two years of life`                        2.26e-
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`           0.0090
## `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  0.3192
## `Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` 0.1473
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`                 0.1291
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                            < 2e-
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`         1.28e-
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`            0.0003
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`          1.23e-
##
## (Intercept)                                                                           *
## StateAL                                                                               *
```

```
## StateAR                                                                  *
## StateAZ
## StateCA                                                                  .
## StateCO
## StateCT                                                                  *
## StateDC                                                                  .
## StateDE                                                                  **
## StateFL                                                                  .
## StateGA                                                                  .
## StateHI
## StateIA
## StateID                                                                  .
## StateIL                                                                  .
## StateIN
## StateKS
## StateKY                                                                  *
## StateLA                                                                  *
## StateMA                                                                  **
## StateMD                                                                  *
## StateME
## StateMI                                                                  *
## StateMN
## StateMO                                                                  .
## StateMS                                                                  *
## StateMT
## StateNC                                                                  *
## StateND
## StateNE
## StateNH                                                                  .
## StateNJ                                                                  .
## StateNM
## StateNV
## StateNY                                                                  **
## StateOH
## StateOK                                                                  *
## StateOR
## StatePA                                                                  .
## StateRI
## StateSC                                                                  *
## StateSD                                                                  .
## StateTN                                                                  **
## StateTX                                                                  .
## StateUT                                                                  .
## StateVA                                                                  *
## StateVT                                                                  *
## StateWA                                                                  *
## StateWI
## StateWV                                                                  *
## StateWY
## `Other spending per Decedent during the last two years of life`          ***
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  **
## `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`
## `Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`
```

```
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                                  ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`               ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`                  ***
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`                ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for gaussian family taken to be 43374.16)
##
##     Null deviance: 102423287  on 2065  degrees of freedom
## Residual deviance:  87008571  on 2006  degrees of freedom
## AIC: 27984
##
## Number of Fisher Scoring iterations: 2
```

From the summary of `glm.model.1`, we can tell that `Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` is not significant. We will remove this variable and fit the model again.

```
##
## Call:
## glm(formula = `Number of deaths among chronically ill patients assigned to hospital` ~
##     State + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`,
##     data = df.chronic)
##
## Coefficients:
##                                                                                  Estimate
## (Intercept)                                                                   -2.098e+02
## StateAL                                                                        2.628e+02
## StateAR                                                                        2.479e+02
## StateAZ                                                                        1.229e+02
## StateCA                                                                        1.846e+02
## StateCO                                                                        8.933e+01
## StateCT                                                                        2.909e+02
## StateDC                                                                        2.409e+02
## StateDE                                                                        3.692e+02
## StateFL                                                                        2.088e+02
## StateGA                                                                        1.837e+02
## StateHI                                                                        1.133e+02
## StateIA                                                                        1.710e+02
## StateID                                                                        2.271e+02
## StateIL                                                                        1.945e+02
## StateIN                                                                        1.803e+02
## StateKS                                                                        1.885e+02
## StateKY                                                                        2.354e+02
## StateLA                                                                        2.475e+02
## StateMA                                                                        3.007e+02
## StateMD                                                                        2.797e+02
```

```
## StateME                                                                  9.507e+01
## StateMI                                                                  2.534e+02
## StateMN                                                                  1.430e+02
## StateMO                                                                  1.886e+02
## StateMS                                                                  2.819e+02
## StateMT                                                                  1.922e+02
## StateNC                                                                  2.397e+02
## StateND                                                                  1.356e+02
## StateNE                                                                  1.480e+02
## StateNH                                                                  2.042e+02
## StateNJ                                                                  2.136e+02
## StateNM                                                                  2.024e+02
## StateNV                                                                  1.735e+02
## StateNY                                                                  2.815e+02
## StateOH                                                                  1.534e+02
## StateOK                                                                  2.623e+02
## StateOR                                                                  1.539e+02
## StatePA                                                                  1.990e+02
## StateRI                                                                  1.592e+02
## StateSC                                                                  2.530e+02
## StateSD                                                                  2.402e+02
## StateTN                                                                  2.970e+02
## StateTX                                                                  1.972e+02
## StateUT                                                                  2.194e+02
## StateVA                                                                  2.780e+02
## StateVT                                                                  3.071e+02
## StateWA                                                                  2.258e+02
## StateWI                                                                  8.201e+01
## StateWV                                                                  2.492e+02
## StateWY                                                                  1.878e+02
## `Other spending per Decedent during the last two years of life`          9.773e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  1.852e-02
## `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  7.614e-03
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`   1.265e-02
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`             1.269e+02
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  4.321e-02
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`  -5.468e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  4.195e-02
##                                                                         Std. Error
## (Intercept)                                                              1.086e+02
## StateAL                                                                  1.119e+02
## StateAR                                                                  1.139e+02
## StateAZ                                                                  1.117e+02
## StateCA                                                                  1.065e+02
## StateCO                                                                  1.140e+02
## StateCT                                                                  1.151e+02
## StateDC                                                                  1.405e+02
## StateDE                                                                  1.361e+02
## StateFL                                                                  1.085e+02
## StateGA                                                                  1.093e+02
## StateHI                                                                  1.283e+02
## StateIA                                                                  1.157e+02
## StateID                                                                  1.269e+02
## StateIL                                                                  1.080e+02
```

```
## StateIN                                                                  1.094e+02
## StateKS                                                                  1.158e+02
## StateKY                                                                  1.110e+02
## StateLA                                                                  1.130e+02
## StateMA                                                                  1.101e+02
## StateMD                                                                  1.105e+02
## StateME                                                                  1.197e+02
## StateMI                                                                  1.091e+02
## StateMN                                                                  1.151e+02
## StateMO                                                                  1.097e+02
## StateMS                                                                  1.135e+02
## StateMT                                                                  1.265e+02
## StateNC                                                                  1.087e+02
## StateND                                                                  1.352e+02
## StateNE                                                                  1.176e+02
## StateNH                                                                  1.207e+02
## StateNJ                                                                  1.089e+02
## StateNM                                                                  1.217e+02
## StateNV                                                                  1.175e+02
## StateNY                                                                  1.073e+02
## StateOH                                                                  1.089e+02
## StateOK                                                                  1.127e+02
## StateOR                                                                  1.142e+02
## StatePA                                                                  1.078e+02
## StateRI                                                                  1.299e+02
## StateSC                                                                  1.118e+02
## StateSD                                                                  1.482e+02
## StateTN                                                                  1.106e+02
## StateTX                                                                  1.082e+02
## StateUT                                                                  1.282e+02
## StateVA                                                                  1.091e+02
## StateVT                                                                  1.416e+02
## StateWA                                                                  1.097e+02
## StateWI                                                                  1.111e+02
## StateWV                                                                  1.158e+02
## StateWY                                                                  1.488e+02
## `Other spending per Decedent during the last two years of life`          1.722e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  7.759e-03
## `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  7.439e-03
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`   8.493e-03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`             1.190e+01
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  7.688e-03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`  1.566e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  9.724e-03
##                                                                          t value
## (Intercept)                                                               -1.932
## StateAL                                                                    2.349
## StateAR                                                                    2.177
## StateAZ                                                                    1.101
## StateCA                                                                    1.734
## StateCO                                                                    0.783
## StateCT                                                                    2.528
## StateDC                                                                    1.714
## StateDE                                                                    2.714
```

```
## StateFL                                                                  1.923
## StateGA                                                                  1.681
## StateHI                                                                  0.883
## StateIA                                                                  1.478
## StateID                                                                  1.790
## StateIL                                                                  1.801
## StateIN                                                                  1.648
## StateKS                                                                  1.628
## StateKY                                                                  2.121
## StateLA                                                                  2.191
## StateMA                                                                  2.731
## StateMD                                                                  2.531
## StateME                                                                  0.794
## StateMI                                                                  2.322
## StateMN                                                                  1.242
## StateMO                                                                  1.720
## StateMS                                                                  2.484
## StateMT                                                                  1.519
## StateNC                                                                  2.205
## StateND                                                                  1.003
## StateNE                                                                  1.259
## StateNH                                                                  1.691
## StateNJ                                                                  1.960
## StateNM                                                                  1.663
## StateNV                                                                  1.476
## StateNY                                                                  2.624
## StateOH                                                                  1.408
## StateOK                                                                  2.326
## StateOR                                                                  1.348
## StatePA                                                                  1.845
## StateRI                                                                  1.226
## StateSC                                                                  2.262
## StateSD                                                                  1.621
## StateTN                                                                  2.686
## StateTX                                                                  1.823
## StateUT                                                                  1.711
## StateVA                                                                  2.547
## StateVT                                                                  2.168
## StateWA                                                                  2.059
## StateWI                                                                  0.738
## StateWV                                                                  2.152
## StateWY                                                                  1.262
## `Other spending per Decedent during the last two years of life`          5.676
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  2.386
## `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  1.024
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`   1.490
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            10.667
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  5.620
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`  -3.491
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  4.314
##                                                                        Pr(>|t|)
## (Intercept)                                                            0.053454
## StateAL                                                                0.018941
## StateAR                                                                0.029606
```

```
## StateAZ                                                                    0.271231
## StateCA                                                                    0.083135
## StateCO                                                                    0.433515
## StateCT                                                                    0.011543
## StateDC                                                                    0.086695
## StateDE                                                                    0.006705
## StateFL                                                                    0.054562
## StateGA                                                                    0.092941
## StateHI                                                                    0.377355
## StateIA                                                                    0.139544
## StateID                                                                    0.073587
## StateIL                                                                    0.071818
## StateIN                                                                    0.099541
## StateKS                                                                    0.103653
## StateKY                                                                    0.034016
## StateLA                                                                    0.028602
## StateMA                                                                    0.006377
## StateMD                                                                    0.011449
## StateME                                                                    0.427187
## StateMI                                                                    0.020331
## StateMN                                                                    0.214499
## StateMO                                                                    0.085669
## StateMS                                                                    0.013060
## StateMT                                                                    0.128819
## StateNC                                                                    0.027593
## StateND                                                                    0.316063
## StateNE                                                                    0.208305
## StateNH                                                                    0.090930
## StateNJ                                                                    0.050079
## StateNM                                                                    0.096545
## StateNV                                                                    0.139974
## StateNY                                                                    0.008754
## StateOH                                                                    0.159211
## StateOK                                                                    0.020092
## StateOR                                                                    0.177898
## StatePA                                                                    0.065209
## StateRI                                                                    0.220484
## StateSC                                                                    0.023782
## StateSD                                                                    0.105100
## StateTN                                                                    0.007299
## StateTX                                                                    0.068399
## StateUT                                                                    0.087147
## StateVA                                                                    0.010941
## StateVT                                                                    0.030260
## StateWA                                                                    0.039656
## StateWI                                                                    0.460347
## StateWV                                                                    0.031518
## StateWY                                                                    0.207127
## `Other spending per Decedent during the last two years of life`            1.58e-08
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`          0.017104
## `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` 0.306182
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`                0.136447
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                           < 2e-16
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`        2.17e-08
```

```
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`          0.000492
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`        1.68e-05
##
## (Intercept)                                                                          .
## StateAL                                                                              *
## StateAR                                                                              *
## StateAZ
## StateCA                                                                              .
## StateCO
## StateCT                                                                              *
## StateDC                                                                              .
## StateDE                                                                              **
## StateFL                                                                              .
## StateGA                                                                              .
## StateHI
## StateIA
## StateID                                                                              .
## StateIL                                                                              .
## StateIN                                                                              .
## StateKS
## StateKY                                                                              *
## StateLA                                                                              *
## StateMA                                                                              **
## StateMD                                                                              *
## StateME
## StateMI                                                                              *
## StateMN
## StateMO                                                                              .
## StateMS                                                                              *
## StateMT
## StateNC                                                                              *
## StateND
## StateNE
## StateNH                                                                              .
## StateNJ                                                                              .
## StateNM                                                                              .
## StateNV
## StateNY                                                                              **
## StateOH
## StateOK                                                                              *
## StateOR
## StatePA                                                                              .
## StateRI
## StateSC                                                                              *
## StateSD
## StateTN                                                                              **
## StateTX                                                                              .
## StateUT                                                                              .
## StateVA                                                                              *
## StateVT                                                                              *
## StateWA                                                                              *
## StateWI
## StateWV                                                                              *
## StateWY
```

```
## `Other spending per Decedent during the last two years of life`                      ***
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`         *
## `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                         ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`       ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`          ***
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`        ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for gaussian family taken to be 43397.95)
##
##     Null deviance: 102423287  on 2065  degrees of freedom
## Residual deviance:  87099686  on 2007  degrees of freedom
## AIC: 27984
##
## Number of Fisher Scoring iterations: 2
```

From the summary of `glm.model.2`, we can tell that `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` is not significant. We will remove this variable and fit the model again.

```
##
## Call:
## glm(formula = `Number of deaths among chronically ill patients assigned to hospital` ~
##     State + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`,
##     data = df.chronic)
##
## Coefficients:
##                                                                                 Estimate
## (Intercept)                                                                   -2.034e+02
## StateAL                                                                        2.626e+02
## StateAR                                                                        2.490e+02
## StateAZ                                                                        1.250e+02
## StateCA                                                                        1.860e+02
## StateCO                                                                        9.115e+01
## StateCT                                                                        2.934e+02
## StateDC                                                                        2.464e+02
## StateDE                                                                        3.719e+02
## StateFL                                                                        2.104e+02
## StateGA                                                                        1.868e+02
## StateHI                                                                        1.148e+02
## StateIA                                                                        1.714e+02
## StateID                                                                        2.268e+02
## StateIL                                                                        1.962e+02
## StateIN                                                                        1.821e+02
## StateKS                                                                        1.891e+02
## StateKY                                                                        2.375e+02
```

```
## StateLA                                                                  2.490e+02
## StateMA                                                                  3.019e+02
## StateMD                                                                  2.802e+02
## StateME                                                                  9.579e+01
## StateMI                                                                  2.552e+02
## StateMN                                                                  1.437e+02
## StateMO                                                                  1.901e+02
## StateMS                                                                  2.837e+02
## StateMT                                                                  1.912e+02
## StateNC                                                                  2.411e+02
## StateND                                                                  1.343e+02
## StateNE                                                                  1.495e+02
## StateNH                                                                  2.043e+02
## StateNJ                                                                  2.161e+02
## StateNM                                                                  2.041e+02
## StateNV                                                                  1.758e+02
## StateNY                                                                  2.832e+02
## StateOH                                                                  1.559e+02
## StateOK                                                                  2.643e+02
## StateOR                                                                  1.531e+02
## StatePA                                                                  2.008e+02
## StateRI                                                                  1.616e+02
## StateSC                                                                  2.556e+02
## StateSD                                                                  2.388e+02
## StateTN                                                                  3.000e+02
## StateTX                                                                  1.994e+02
## StateUT                                                                  2.198e+02
## StateVA                                                                  2.805e+02
## StateVT                                                                  3.088e+02
## StateWA                                                                  2.248e+02
## StateWI                                                                  8.193e+01
## StateWV                                                                  2.513e+02
## StateWY                                                                  1.880e+02
## `Other spending per Decedent during the last two years of life`          9.796e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  1.840e-02
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`   1.281e-02
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`             1.265e+02
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  4.346e-02
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`  -5.448e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  4.208e-02
##                                                                         Std. Error
## (Intercept)                                                              1.084e+02
## StateAL                                                                  1.119e+02
## StateAR                                                                  1.139e+02
## StateAZ                                                                  1.117e+02
## StateCA                                                                  1.065e+02
## StateCO                                                                  1.140e+02
## StateCT                                                                  1.150e+02
## StateDC                                                                  1.404e+02
## StateDE                                                                  1.360e+02
## StateFL                                                                  1.085e+02
## StateGA                                                                  1.092e+02
## StateHI                                                                  1.283e+02
## StateIA                                                                  1.157e+02
```

```
## StateID                                                                  1.269e+02
## StateIL                                                                  1.080e+02
## StateIN                                                                  1.094e+02
## StateKS                                                                  1.158e+02
## StateKY                                                                  1.110e+02
## StateLA                                                                  1.130e+02
## StateMA                                                                  1.101e+02
## StateMD                                                                  1.105e+02
## StateME                                                                  1.197e+02
## StateMI                                                                  1.091e+02
## StateMN                                                                  1.151e+02
## StateMO                                                                  1.097e+02
## StateMS                                                                  1.135e+02
## StateMT                                                                  1.265e+02
## StateNC                                                                  1.087e+02
## StateND                                                                  1.352e+02
## StateNE                                                                  1.176e+02
## StateNH                                                                  1.207e+02
## StateNJ                                                                  1.089e+02
## StateNM                                                                  1.217e+02
## StateNV                                                                  1.175e+02
## StateNY                                                                  1.073e+02
## StateOH                                                                  1.089e+02
## StateOK                                                                  1.127e+02
## StateOR                                                                  1.142e+02
## StatePA                                                                  1.078e+02
## StateRI                                                                  1.299e+02
## StateSC                                                                  1.118e+02
## StateSD                                                                  1.482e+02
## StateTN                                                                  1.106e+02
## StateTX                                                                  1.081e+02
## StateUT                                                                  1.282e+02
## StateVA                                                                  1.091e+02
## StateVT                                                                  1.416e+02
## StateWA                                                                  1.097e+02
## StateWI                                                                  1.111e+02
## StateWV                                                                  1.158e+02
## StateWY                                                                  1.488e+02
## `Other spending per Decedent during the last two years of life`          1.722e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  7.758e-03
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`   8.492e-03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`             1.189e+01
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  7.684e-03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`  1.566e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  9.724e-03
##                                                                         t value
## (Intercept)                                                              -1.877
## StateAL                                                                   2.347
## StateAR                                                                   2.186
## StateAZ                                                                   1.120
## StateCA                                                                   1.747
## StateCO                                                                   0.799
## StateCT                                                                   2.550
## StateDC                                                                   1.754
```

```
## StateDE                                                                  2.734
## StateFL                                                                  1.939
## StateGA                                                                  1.710
## StateHI                                                                  0.894
## StateIA                                                                  1.481
## StateID                                                                  1.787
## StateIL                                                                  1.817
## StateIN                                                                  1.664
## StateKS                                                                  1.634
## StateKY                                                                  2.140
## StateLA                                                                  2.204
## StateMA                                                                  2.742
## StateMD                                                                  2.535
## StateME                                                                  0.800
## StateMI                                                                  2.338
## StateMN                                                                  1.248
## StateMO                                                                  1.733
## StateMS                                                                  2.500
## StateMT                                                                  1.511
## StateNC                                                                  2.218
## StateND                                                                  0.993
## StateNE                                                                  1.271
## StateNH                                                                  1.692
## StateNJ                                                                  1.984
## StateNM                                                                  1.677
## StateNV                                                                  1.497
## StateNY                                                                  2.640
## StateOH                                                                  1.432
## StateOK                                                                  2.345
## StateOR                                                                  1.341
## StatePA                                                                  1.862
## StateRI                                                                  1.244
## StateSC                                                                  2.286
## StateSD                                                                  1.612
## StateTN                                                                  2.713
## StateTX                                                                  1.844
## StateUT                                                                  1.715
## StateVA                                                                  2.571
## StateVT                                                                  2.181
## StateWA                                                                  2.050
## StateWI                                                                  0.738
## StateWV                                                                  2.170
## StateWY                                                                  1.263
## `Other spending per Decedent during the last two years of life`          5.690
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  2.372
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`   1.508
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            10.639
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  5.656
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`  -3.478
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  4.328
##                                                                        Pr(>|t|)
## (Intercept)                                                            0.060715
## StateAL                                                                0.019023
## StateAR                                                                0.028902
```

```
## StateAZ                                                                    0.263051
## StateCA                                                                    0.080812
## StateCO                                                                    0.424174
## StateCT                                                                    0.010832
## StateDC                                                                    0.079544
## StateDE                                                                    0.006306
## StateFL                                                                    0.052687
## StateGA                                                                    0.087461
## StateHI                                                                    0.371288
## StateIA                                                                    0.138702
## StateID                                                                    0.074061
## StateIL                                                                    0.069332
## StateIN                                                                    0.096245
## StateKS                                                                    0.102420
## StateKY                                                                    0.032481
## StateLA                                                                    0.027646
## StateMA                                                                    0.006161
## StateMD                                                                    0.011305
## StateME                                                                    0.423679
## StateMI                                                                    0.019486
## StateMN                                                                    0.212248
## StateMO                                                                    0.083224
## StateMS                                                                    0.012497
## StateMT                                                                    0.130849
## StateNC                                                                    0.026640
## StateND                                                                    0.320780
## StateNE                                                                    0.203783
## StateNH                                                                    0.090812
## StateNJ                                                                    0.047347
## StateNM                                                                    0.093742
## StateNV                                                                    0.134636
## StateNY                                                                    0.008347
## StateOH                                                                    0.152427
## StateOK                                                                    0.019130
## StateOR                                                                    0.180231
## StatePA                                                                    0.062685
## StateRI                                                                    0.213599
## StateSC                                                                    0.022347
## StateSD                                                                    0.107110
## StateTN                                                                    0.006728
## StateTX                                                                    0.065274
## StateUT                                                                    0.086545
## StateVA                                                                    0.010210
## StateVT                                                                    0.029317
## StateWA                                                                    0.040504
## StateWI                                                                    0.460791
## StateWV                                                                    0.030117
## StateWY                                                                    0.206604
## `Other spending per Decedent during the last two years of life`            1.46e-08
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   0.017785
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`     0.131719
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                < 2e-16
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 1.77e-08
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    0.000516
```

```
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  1.58e-05
##
## (Intercept)                                                                     .
## StateAL                                                                         *
## StateAR                                                                         *
## StateAZ
## StateCA                                                                         .
## StateCO
## StateCT                                                                         *
## StateDC                                                                         .
## StateDE                                                                         **
## StateFL                                                                         .
## StateGA                                                                         .
## StateHI
## StateIA
## StateID                                                                         .
## StateIL                                                                         .
## StateIN                                                                         .
## StateKS
## StateKY                                                                         *
## StateLA                                                                         *
## StateMA                                                                         **
## StateMD                                                                         *
## StateME
## StateMI                                                                         *
## StateMN
## StateMO                                                                         .
## StateMS                                                                         *
## StateMT
## StateNC                                                                         *
## StateND
## StateNE
## StateNH                                                                         .
## StateNJ                                                                         *
## StateNM                                                                         .
## StateNV
## StateNY                                                                         **
## StateOH
## StateOK                                                                         *
## StateOR
## StatePA                                                                         .
## StateRI
## StateSC                                                                         *
## StateSD
## StateTN                                                                         **
## StateTX                                                                         .
## StateUT                                                                         .
## StateVA                                                                         *
## StateVT                                                                         *
## StateWA                                                                         *
## StateWI
## StateWV                                                                         *
## StateWY
## `Other spending per Decedent during the last two years of life`                 ***
```

```
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   *
## `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                    ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    ***
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for gaussian family taken to be 43398.98)
##
##     Null deviance: 102423287  on 2065  degrees of freedom
## Residual deviance:  87145150  on 2008  degrees of freedom
## AIC: 27983
##
## Number of Fisher Scoring iterations: 2
```

From the summary of `glm.model.3`, we can tell that `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life` is not significant. We will remove this variable and fit the model again.

```
##
## Call:
## glm(formula = `Number of deaths among chronically ill patients assigned to hospital` ~
##     State + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`,
##     data = df.chronic)
##
## Coefficients:
##                                                                                  Estimate
## (Intercept)                                                                    -1.973e+02
## StateAL                                                                         2.673e+02
## StateAR                                                                         2.559e+02
## StateAZ                                                                         1.261e+02
## StateCA                                                                         1.960e+02
## StateCO                                                                         1.007e+02
## StateCT                                                                         3.103e+02
## StateDC                                                                         2.555e+02
## StateDE                                                                         3.826e+02
## StateFL                                                                         2.244e+02
## StateGA                                                                         1.917e+02
## StateHI                                                                         1.156e+02
## StateIA                                                                         1.798e+02
## StateID                                                                         2.308e+02
## StateIL                                                                         2.109e+02
## StateIN                                                                         2.002e+02
## StateKS                                                                         1.986e+02
## StateKY                                                                         2.516e+02
## StateLA                                                                         2.607e+02
## StateMA                                                                         3.155e+02
## StateMD                                                                         2.944e+02
## StateME                                                                         9.937e+01
```

```
## StateMI                                                                  2.656e+02
## StateMN                                                                  1.507e+02
## StateMO                                                                  2.020e+02
## StateMS                                                                  2.957e+02
## StateMT                                                                  1.941e+02
## StateNC                                                                  2.512e+02
## StateND                                                                  1.396e+02
## StateNE                                                                  1.651e+02
## StateNH                                                                  2.173e+02
## StateNJ                                                                  2.332e+02
## StateNM                                                                  2.080e+02
## StateNV                                                                  1.809e+02
## StateNY                                                                  2.959e+02
## StateOH                                                                  1.729e+02
## StateOK                                                                  2.722e+02
## StateOR                                                                  1.544e+02
## StatePA                                                                  2.130e+02
## StateRI                                                                  1.774e+02
## StateSC                                                                  2.628e+02
## StateSD                                                                  2.461e+02
## StateTN                                                                  3.143e+02
## StateTX                                                                  2.119e+02
## StateUT                                                                  2.329e+02
## StateVA                                                                  2.889e+02
## StateVT                                                                  3.243e+02
## StateWA                                                                  2.295e+02
## StateWI                                                                  9.042e+01
## StateWV                                                                  2.593e+02
## StateWY                                                                  2.052e+02
## `Other spending per Decedent during the last two years of life`          9.946e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  1.848e-02
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`             1.237e+02
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  4.351e-02
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`  -5.453e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  4.119e-02
##                                                                         Std. Error
## (Intercept)                                                              1.084e+02
## StateAL                                                                  1.119e+02
## StateAR                                                                  1.138e+02
## StateAZ                                                                  1.117e+02
## StateCA                                                                  1.063e+02
## StateCO                                                                  1.139e+02
## StateCT                                                                  1.145e+02
## StateDC                                                                  1.404e+02
## StateDE                                                                  1.359e+02
## StateFL                                                                  1.082e+02
## StateGA                                                                  1.092e+02
## StateHI                                                                  1.284e+02
## StateIA                                                                  1.156e+02
## StateID                                                                  1.269e+02
## StateIL                                                                  1.076e+02
## StateIN                                                                  1.088e+02
## StateKS                                                                  1.156e+02
## StateKY                                                                  1.106e+02
```

```
## StateLA                                                                 1.128e+02
## StateMA                                                                 1.098e+02
## StateMD                                                                 1.101e+02
## StateME                                                                 1.197e+02
## StateMI                                                                 1.090e+02
## StateMN                                                                 1.151e+02
## StateMO                                                                 1.094e+02
## StateMS                                                                 1.132e+02
## StateMT                                                                 1.265e+02
## StateNC                                                                 1.085e+02
## StateND                                                                 1.352e+02
## StateNE                                                                 1.172e+02
## StateNH                                                                 1.205e+02
## StateNJ                                                                 1.084e+02
## StateNM                                                                 1.217e+02
## StateNV                                                                 1.175e+02
## StateNY                                                                 1.070e+02
## StateOH                                                                 1.084e+02
## StateOK                                                                 1.126e+02
## StateOR                                                                 1.142e+02
## StatePA                                                                 1.076e+02
## StateRI                                                                 1.295e+02
## StateSC                                                                 1.118e+02
## StateSD                                                                 1.481e+02
## StateTN                                                                 1.102e+02
## StateTX                                                                 1.079e+02
## StateUT                                                                 1.279e+02
## StateVA                                                                 1.090e+02
## StateVT                                                                 1.413e+02
## StateWA                                                                 1.097e+02
## StateWI                                                                 1.110e+02
## StateWV                                                                 1.157e+02
## StateWY                                                                 1.484e+02
## `Other spending per Decedent during the last two years of life`         1.719e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  7.760e-03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            1.175e+01
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  7.687e-03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`  1.567e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  9.709e-03
##                                                                        t value
## (Intercept)                                                             -1.821
## StateAL                                                                  2.389
## StateAR                                                                  2.249
## StateAZ                                                                  1.129
## StateCA                                                                  1.844
## StateCO                                                                  0.884
## StateCT                                                                  2.710
## StateDC                                                                  1.820
## StateDE                                                                  2.815
## StateFL                                                                  2.074
## StateGA                                                                  1.755
## StateHI                                                                  0.901
## StateIA                                                                  1.556
## StateID                                                                  1.819
```

```
## StateIL                                                                  1.961
## StateIN                                                                  1.840
## StateKS                                                                  1.718
## StateKY                                                                  2.275
## StateLA                                                                  2.312
## StateMA                                                                  2.874
## StateMD                                                                  2.673
## StateME                                                                  0.830
## StateMI                                                                  2.438
## StateMN                                                                  1.309
## StateMO                                                                  1.846
## StateMS                                                                  2.612
## StateMT                                                                  1.534
## StateNC                                                                  2.315
## StateND                                                                  1.032
## StateNE                                                                  1.410
## StateNH                                                                  1.804
## StateNJ                                                                  2.152
## StateNM                                                                  1.709
## StateNV                                                                  1.540
## StateNY                                                                  2.767
## StateOH                                                                  1.595
## StateOK                                                                  2.417
## StateOR                                                                  1.352
## StatePA                                                                  1.980
## StateRI                                                                  1.370
## StateSC                                                                  2.352
## StateSD                                                                  1.661
## StateTN                                                                  2.852
## StateTX                                                                  1.965
## StateUT                                                                  1.820
## StateVA                                                                  2.650
## StateVT                                                                  2.296
## StateWA                                                                  2.093
## StateWI                                                                  0.815
## StateWV                                                                  2.241
## StateWY                                                                  1.383
## `Other spending per Decedent during the last two years of life`          5.784
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  2.381
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            10.529
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  5.661
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`  -3.481
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  4.243
##                                                                       Pr(>|t|)
## (Intercept)                                                           0.068765
## StateAL                                                               0.016975
## StateAR                                                               0.024641
## StateAZ                                                               0.259080
## StateCA                                                               0.065392
## StateCO                                                               0.376647
## StateCT                                                               0.006791
## StateDC                                                               0.068882
## StateDE                                                               0.004921
## StateFL                                                               0.038194
```

```
## StateGA                                                                    0.079377
## StateHI                                                                    0.367836
## StateIA                                                                    0.119917
## StateID                                                                    0.069054
## StateIL                                                                    0.050069
## StateIN                                                                    0.065952
## StateKS                                                                    0.086031
## StateKY                                                                    0.023027
## StateLA                                                                    0.020885
## StateMA                                                                    0.004099
## StateMD                                                                    0.007577
## StateME                                                                    0.406636
## StateMI                                                                    0.014873
## StateMN                                                                    0.190637
## StateMO                                                                    0.065053
## StateMS                                                                    0.009077
## StateMT                                                                    0.125126
## StateNC                                                                    0.020709
## StateND                                                                    0.302170
## StateNE                                                                    0.158831
## StateNH                                                                    0.071431
## StateNJ                                                                    0.031524
## StateNM                                                                    0.087590
## StateNV                                                                    0.123648
## StateNY                                                                    0.005714
## StateOH                                                                    0.110811
## StateOK                                                                    0.015741
## StateOR                                                                    0.176588
## StatePA                                                                    0.047853
## StateRI                                                                    0.170843
## StateSC                                                                    0.018784
## StateSD                                                                    0.096802
## StateTN                                                                    0.004388
## StateTX                                                                    0.049583
## StateUT                                                                    0.068883
## StateVA                                                                    0.008102
## StateVT                                                                    0.021803
## StateWA                                                                    0.036479
## StateWI                                                                    0.415224
## StateWV                                                                    0.025163
## StateWY                                                                    0.166927
## `Other spending per Decedent during the last two years of life`            8.43e-09
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   0.017342
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                < 2e-16
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 1.72e-08
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    0.000511
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  2.31e-05
##
## (Intercept)                                                                .
## StateAL                                                                    *
## StateAR                                                                    *
## StateAZ
## StateCA                                                                    .
## StateCO
```

```
## StateCT                                                                **
## StateDC                                                                .
## StateDE                                                                **
## StateFL                                                                *
## StateGA                                                                .
## StateHI
## StateIA
## StateID                                                                .
## StateIL                                                                .
## StateIN                                                                .
## StateKS                                                                .
## StateKY                                                                *
## StateLA                                                                *
## StateMA                                                                **
## StateMD                                                                **
## StateME
## StateMI                                                                *
## StateMN
## StateMO                                                                .
## StateMS                                                                **
## StateMT
## StateNC                                                                *
## StateND
## StateNE
## StateNH                                                                .
## StateNJ                                                                *
## StateNM                                                                .
## StateNV
## StateNY                                                                **
## StateOH
## StateOK                                                                *
## StateOR
## StatePA                                                                *
## StateRI
## StateSC                                                                *
## StateSD                                                                .
## StateTN                                                                **
## StateTX                                                                *
## StateUT                                                                .
## StateVA                                                                **
## StateVT                                                                *
## StateWA                                                                *
## StateWI
## StateWV                                                                *
## StateWY
## `Other spending per Decedent during the last two years of life`        ***
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   *
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`           ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    ***
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## (Dispersion parameter for gaussian family taken to be 43426.5)
##
##     Null deviance: 102423287  on 2065  degrees of freedom
## Residual deviance:  87243838  on 2009  degrees of freedom
## AIC: 27984
##
## Number of Fisher Scoring iterations: 2
```

By this step, we have removed all the variables that are not significant. The final model is `glm.model.4`, which includes `State`, `Other spending per Decedent during the last two years of life`, `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`, `Standardized FTE physician labor: Ratio MS/PC (calculated)`, `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`, `Home Health Agency Visits per Decedent during the Last Six Months of Life`, and `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` as predictors.

Adding Random Effect to the Model

In the previous section, we have used GLM to do the variable selection. However, in the exploratory data analysis, we have found that there seems to be a difference between region and states, suggesting that a multilevel model might be more appropriate. Adding a random effect to the model can help us to account for the variance between groups, thus providing a more accurate estimate of the predictions.

In this section, we will use the `lmer` function to fit a multilevel model to the data. However, different with the previous part, we will use a forward selection. We will start with the simplest model, which only includes the variables we found in the previous section. We will then add one variable at a time and use `anova` test to check the AIC value and p-values to determine if we will keep the variable in the model. For instance, if the p-value suggests that the two model are not significantly different, we will remove the variable from the model, in other words, we will keep the simple model with fewer variables when the two models are not significantly different. On the other hand, when the p-value suggests that the two models are significantly different, we will keep the more complex model with more variables (usually has a lower AIC value).

We will start by adding the random effect on `State` to the model. The model is `lmer.model.1`.

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
## `Number of deaths among chronically ill patients assigned to hospital` ~
##     1 + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
##         (1 | State)
##    Data: df.chronic
##
## REML criterion at convergence: 27977.2
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.1891 -0.6467 -0.2530  0.3819  7.8389
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
```

```
##  State    (Intercept)  1702     41.26
##  Residual              43477    208.51
## Number of obs: 2066, groups:  State, 51
##
## Fixed effects:
##                                                                                 Estimate
## (Intercept)                                                                    3.084e+01
## `Other spending per Decedent during the last two years of life`                9.234e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   1.575e-02
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   1.170e+02
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 4.230e-02
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`   -3.354e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  3.473e-02
##                                                                               Std. Error
## (Intercept)                                                                    2.540e+01
## `Other spending per Decedent during the last two years of life`                1.591e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   7.619e-03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   1.134e+01
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 7.527e-03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    1.378e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  8.888e-03
##                                                                                      df
## (Intercept)                                                                    9.858e+02
## `Other spending per Decedent during the last two years of life`                1.152e+03
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   2.054e+03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   1.949e+03
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 2.035e+03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    7.028e+02
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  9.583e+02
##                                                                               t value
## (Intercept)                                                                     1.215
## `Other spending per Decedent during the last two years of life`                 5.803
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    2.067
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   10.317
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  5.619
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    -2.434
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   3.907
##                                                                               Pr(>|t|)
## (Intercept)                                                                     0.2248
## `Other spending per Decedent during the last two years of life`                8.43e-09
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    0.0388
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                    < 2e-16
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 2.18e-08
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     0.0152
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  9.99e-05
##
## (Intercept)
## `Other spending per Decedent during the last two years of life`                ***
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   *
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    *
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##                (Intr) `spDdtltyol `IBIp1DdtLTYoL `FplRM( `&SUDpDdtLSMoL
## `spDdtltyol    -0.185
## `IBIp1DdtLTYoL -0.359  0.007
## `SFTEpl:RM(    -0.441 -0.213       0.011
## `&SUDpDdtLSMoL -0.432  0.038       0.116          0.018
## `HAVpDdtLSMoL  -0.377 -0.236      -0.039         -0.020   0.017
## `oDEIHdtLSMoL  -0.287 -0.145       0.018         -0.054   0.056
##                `HAVpDdtLSMoL
## `spDdtltyol
## `IBIp1DdtLTYoL
## `SFTEpl:RM(
## `&SUDpDdtLSMoL
## `HAVpDdtLSMoL
## `oDEIHdtLSMoL  -0.028
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
```

From the `anova` test we can clearly see that the model with random effect of `State` is significantly different from the model without random effect of `State`, and also have a lower AIC. Therefore, we will keep the random effect of `State` in the model.

```
## Data: df.chronic
## Models:
## lmer.model.1: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
## glm.model.4: `Number of deaths among chronically ill patients assigned to hospital` ~ State + `Other
##              npar   AIC   BIC logLik deviance Chisq Df Pr(>Chisq)
## lmer.model.1    9 27980 28031 -13981    27962
## glm.model.4    58 27984 28310 -13934    27868  94.6 49  9.992e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Then, we will add the random effect on `Other spending per Decedent during the last two years of life` on `Hospital Name` level, which will makes the model `lmer.model.2`

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
## `Number of deaths among chronically ill patients assigned to hospital` ~
##     1 + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
##         (1 | State) + (0 + `Other spending per Decedent during the last two years of life` |
##         `Hospital Name`)
##    Data: df.chronic
##
## REML criterion at convergence: 27896.3
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.6670 -0.5274 -0.2149  0.3222  4.9840
```

```
##
## Random effects:
##  Groups        Name
##  Hospital Name `Other spending per Decedent during the last two years of life`
##  State         (Intercept)
##  Residual
##  Variance  Std.Dev.
##  2.470e-02   0.1571
##  1.018e+03  31.9118
##  2.631e+04 162.2186
## Number of obs: 2066, groups:  Hospital Name, 2030; State, 51
##
## Fixed effects:
##                                                                          Estimate
## (Intercept)                                                             2.601e+01
## `Other spending per Decedent during the last two years of life`         1.112e-01
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    1.378e-02
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            1.104e+02
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  4.180e-02
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    -2.525e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   3.072e-02
##                                                                        Std. Error
## (Intercept)                                                             2.374e+01
## `Other spending per Decedent during the last two years of life`         1.719e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    7.210e-03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            1.078e+01
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  7.264e-03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     1.338e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   8.322e-03
##                                                                               df
## (Intercept)                                                             9.364e+02
## `Other spending per Decedent during the last two years of life`         1.062e+03
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    1.773e+03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            1.709e+03
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  1.903e+03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     5.420e+02
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   7.679e+02
##                                                                        t value
## (Intercept)                                                              1.095
## `Other spending per Decedent during the last two years of life`          6.470
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`     1.911
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            10.249
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`   5.754
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     -1.886
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`    3.692
##                                                                       Pr(>|t|)
## (Intercept)                                                           0.273671
## `Other spending per Decedent during the last two years of life`       1.49e-10
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   0.056174
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`           < 2e-16
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 1.01e-08
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    0.059778
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  0.000238
##
```

```
## (Intercept)
## `Other spending per Decedent during the last two years of life`                ***
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   .
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    .
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##                (Intr) `spDdtltyol `IBIp1DdtLTYoL `FplRM( `&SUDpDdtLSMoL
## `spDdtltyol    -0.215
## `IBIp1DdtLTYoL -0.357  0.001
## `SFTEpl:RM(    -0.431 -0.220      -0.003
## `&SUDpDdtLSMoL -0.438  0.043       0.099          0.017
## `HAVpDdtLSMoL  -0.390 -0.219      -0.022         -0.005   0.007
## `oDEIHdtLSMoL  -0.255 -0.135       0.021         -0.068   0.060
##                `HAVpDdtLSMoL
## `spDdtltyol
## `IBIp1DdtLTYoL
## `SFTEpl:RM(
## `&SUDpDdtLSMoL
## `HAVpDdtLSMoL
## `oDEIHdtLSMoL  -0.066
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.666733 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

From the anova test, we see that lmer.model.2 is better than lmer.model.1, so we keep the random effect of Other spending per Decedent during the last two years of life from lmer.model.2.

```
## Data: df.chronic
## Models:
## lmer.model.1: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
## lmer.model.2: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
##              npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## lmer.model.1    9 27980 28031 -13981    27962
## lmer.model.2   10 27901 27957 -13940    27881 81.664  1  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Next, we will add the random effect of Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life on Hospital Name level to the model, which will make the model lmer.model.3.

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
## `Number of deaths among chronically ill patients assigned to hospital` ~
##     1 + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
```

```
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
##         (1 | State) + (0 + `Other spending per Decedent during the last two years of life` |
##         `Hospital Name`) + (0 + `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years
##         `Hospital Name`)
##    Data: df.chronic
##
## REML criterion at convergence: 27912.3
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.6022 -0.5239 -0.2096  0.3270  4.6124
##
## Random effects:
##  Groups
##  Hospital.Name
##  Hospital.Name.1
##  State
##  Residual
##  Name
##  `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`
##  `Other spending per Decedent during the last two years of life`
##  (Intercept)
##
##  Variance  Std.Dev.
##  1.045e-03   0.03232
##  2.541e-02   0.15941
##  3.929e+00   1.98213
##  2.523e+04 158.83041
## Number of obs: 2066, groups:  Hospital Name, 2030; State, 51
##
## Fixed effects:
##                                                                                 Estimate
## (Intercept)                                                                    3.239e+01
## `Other spending per Decedent during the last two years of life`                1.109e-01
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   1.222e-02
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   1.025e+02
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 4.397e-02
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`   -1.657e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  2.472e-02
##                                                                               Std. Error
## (Intercept)                                                                    2.223e+01
## `Other spending per Decedent during the last two years of life`                1.612e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   7.221e-03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   1.055e+01
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 7.198e-03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    1.190e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  7.438e-03
##                                                                                      df
## (Intercept)                                                                    1.788e+03
## `Other spending per Decedent during the last two years of life`                1.605e+03
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   1.465e+03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   1.868e+03
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 1.831e+03
```

```
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     2.049e+03
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   1.951e+03
##                                                                                 t value
## (Intercept)                                                                       1.457
## `Other spending per Decedent during the last two years of life`                   6.881
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`      1.693
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                      9.716
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`   6.109
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     -1.392
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`    3.324
##                                                                                Pr(>|t|)
## (Intercept)                                                                    0.145225
## `Other spending per Decedent during the last two years of life`                8.47e-12
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   0.090754
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                    < 2e-16
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 1.22e-09
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    0.164065
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  0.000903
##
## (Intercept)
## `Other spending per Decedent during the last two years of life`                ***
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   .
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##                (Intr) `spDdtltyol `IBIp1DdtLTYoL `FplRM( `&SUDpDdtLSMoL
## `spDdtltyol    -0.214
## `IBIp1DdtLTYoL -0.377 -0.026
## `SFTEpl:RM(    -0.475 -0.237      -0.016
## `&SUDpDdtLSMoL -0.465  0.060       0.108          0.023
## `HAVpDdtLSMoL  -0.385 -0.244      -0.004          0.052   0.024
## `oDEIHdtLSMoL  -0.214 -0.093       0.050         -0.079   0.035
##                `HAVpDdtLSMoL
## `spDdtltyol
## `IBIp1DdtLTYoL
## `SFTEpl:RM(
## `&SUDpDdtLSMoL
## `HAVpDdtLSMoL
## `oDEIHdtLSMoL  -0.140
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
## optimizer (nloptwrap) convergence code: 0 (OK)
## unable to evaluate scaled gradient
## Model failed to converge: degenerate  Hessian with 1 negative eigenvalues
```

From the `anova` test, we see that `lmer.model.3` is not significantly different from `lmer.model.2`, so we remove the random effect of `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` from `lmer.model.3`.

```
## Data: df.chronic
```

```
## Models:
## lmer.model.2: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
## lmer.model.3: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
##              npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## lmer.model.2   10 27901 27957 -13940    27881
## lmer.model.3   11 27901 27963 -13939    27879 1.8115  1     0.1783
```

Next, we will add the random effect of `Standardized FTE physician labor: Ratio MS/PC (calculated)` on `Hospital Name` level to the model, which will make the model `lmer.model.4`.

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
## `Number of deaths among chronically ill patients assigned to hospital` ~
##     1 + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
##         (1 | State) + (0 + `Other spending per Decedent during the last two years of life` |
##         `Hospital Name`) + (0 + `Standardized FTE physician labor: Ratio MS/PC (calculated)` |
##         `Hospital Name`)
##    Data: df.chronic
##
## REML criterion at convergence: 27878.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.3217 -0.4333 -0.1742  0.2666  4.8153
##
## Random effects:
##  Groups
##  Hospital.Name
##  Hospital.Name.1
##  State
##  Residual
##  Name                                                                Variance
##  `Standardized FTE physician labor: Ratio MS/PC (calculated)`    9.425e+03
##  `Other spending per Decedent during the last two years of life` 1.435e-02
##  (Intercept)                                                         1.159e+03
##                                                                      1.693e+04
##  Std.Dev.
##   97.0848
##    0.1198
##   34.0420
##  130.1176
## Number of obs: 2066, groups:  Hospital Name, 2030; State, 51
##
## Fixed effects:
##                                                                              Estimate
## (Intercept)                                                                 1.710e+01
## `Other spending per Decedent during the last two years of life`             9.462e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    1.475e-02
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                1.290e+02
```

```
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  4.117e-02
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    -2.911e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   3.167e-02
##                                                                                Std. Error
## (Intercept)                                                                     2.326e+01
## `Other spending per Decedent during the last two years of life`                 1.670e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    7.056e-03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                    1.211e+01
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  7.154e-03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     1.312e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   8.233e-03
##                                                                                        df
## (Intercept)                                                                     8.618e+02
## `Other spending per Decedent during the last two years of life`                 9.172e+02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    1.795e+03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                    1.118e+03
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  1.882e+03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     5.741e+02
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   8.556e+02
##                                                                                t value
## (Intercept)                                                                      0.735
## `Other spending per Decedent during the last two years of life`                  5.665
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`     2.090
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                    10.653
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`   5.755
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     -2.219
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`    3.847
##                                                                                Pr(>|t|)
## (Intercept)                                                                    0.462377
## `Other spending per Decedent during the last two years of life`                1.97e-08
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   0.036744
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                    < 2e-16
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 1.01e-08
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    0.026872
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  0.000129
##
## (Intercept)
## `Other spending per Decedent during the last two years of life`                ***
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   *
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    *
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##                (Intr) `spDdtltyol `IBIp1DdtLTYoL `FplRM( `&SUDpDdtLSMoL
## `spDdtltyol    -0.185
## `IBIp1DdtLTYoL -0.347  0.001
## `SFTEpl:RM(    -0.425 -0.266      -0.018
## `&SUDpDdtLSMoL -0.438  0.040       0.096          0.022
## `HAVpDdtLSMoL  -0.385 -0.205      -0.021         -0.024  -0.003
## `oDEIHdtLSMoL  -0.245 -0.142       0.024         -0.083   0.063
```

```
##                `HAVpDdtLSMoL
## `spDdtltyol
## `IBIp1DdtLTYoL
## `SFTEpl:RM(
## `&SUDpDdtLSMoL
## `HAVpDdtLSMoL
## `oDEIHdtLSMoL  -0.062
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 1.54542 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

From the `anova` test, we see that `lmer.model.4` is better than `lmer.model.2`, so we keep the random effect of `Standardized FTE physician labor: Ratio MS/PC (calculated)` in `lmer.model.4`.

```
## Data: df.chronic
## Models:
## lmer.model.2: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other spe
## lmer.model.4: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other spe
##              npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## lmer.model.2   10 27901 27957 -13940    27881
## lmer.model.4   11 27880 27942 -13929    27858 22.132  1  2.545e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Next, we will add the random effect of `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` on `Hospital Name` level to the model, which will make the model `lmer.model.5`.

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
## `Number of deaths among chronically ill patients assigned to hospital` ~
##     1 + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
##         (1 | State) + (0 + `Other spending per Decedent during the last two years of life` |
##         `Hospital Name`) + (0 + `Standardized FTE physician labor: Ratio MS/PC (calculated)` |
##         `Hospital Name`) + (0 + `Medical & Surgical Unit Days per Decedent during the Last Six Months
##         `Hospital Name`)
##    Data: df.chronic
##
## REML criterion at convergence: 27892.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.5808 -0.3734 -0.1526  0.2339  5.2714
##
## Random effects:
##  Groups
##  Hospital.Name
##  Hospital.Name.1
```

```
##  Hospital.Name.2
##  State
##  Residual
##  Name
##  `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`
##  `Standardized FTE physician labor: Ratio MS/PC (calculated)`
##  `Other spending per Decedent during the last two years of life`
##  (Intercept)
##
##  Variance  Std.Dev.
##  9.099e-04   0.03016
##  1.241e+04 111.38414
##  1.134e-02   0.10647
##  1.346e+03  36.69028
##  1.318e+04 114.79291
## Number of obs: 2066, groups:  Hospital Name, 2030; State, 51
##
## Fixed effects:
##                                                                          Estimate
## (Intercept)                                                             1.839e+01
## `Other spending per Decedent during the last two years of life`         8.846e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    1.516e-02
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            1.342e+02
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  3.983e-02
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    -3.244e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   3.210e-02
##                                                                        Std. Error
## (Intercept)                                                             2.310e+01
## `Other spending per Decedent during the last two years of life`         1.657e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    7.062e-03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            1.237e+01
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  7.146e-03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     1.309e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   8.236e-03
##                                                                              df
## (Intercept)                                                             8.548e+02
## `Other spending per Decedent during the last two years of life`         8.741e+02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    1.499e+03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`            1.242e+03
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  1.758e+03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     6.320e+02
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   9.632e+02
##                                                                         t value
## (Intercept)                                                               0.796
## `Other spending per Decedent during the last two years of life`           5.338
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`     2.147
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`             10.849
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`   5.574
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     -2.478
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`    3.897
##                                                                        Pr(>|t|)
## (Intercept)                                                            0.426153
## `Other spending per Decedent during the last two years of life`        1.20e-07
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   0.031961
```

```
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                     < 2e-16
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 2.88e-08
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    0.013473
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  0.000104
##
## (Intercept)
## `Other spending per Decedent during the last two years of life`                ***
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   *
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    *
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##                (Intr) `spDdtltyol `IBIp1DdtLTYoL `FplRM( `&SUDpDdtLSMoL
## `spDdtltyol    -0.179
## `IBIp1DdtLTYoL -0.346  0.001
## `SFTEpl:RM(    -0.418 -0.271      -0.025
## `&SUDpDdtLSMoL -0.427  0.036       0.102          0.013
## `HAVpDdtLSMoL  -0.382 -0.204      -0.025         -0.031  -0.006
## `oDEIHdtLSMoL  -0.247 -0.145       0.025         -0.086   0.062
##                `HAVpDdtLSMoL
## `spDdtltyol
## `IBIp1DdtLTYoL
## `SFTEpl:RM(
## `&SUDpDdtLSMoL
## `HAVpDdtLSMoL
## `oDEIHdtLSMoL  -0.056
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 2.61628 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
## Model is nearly unidentifiable: large eigenvalue ratio
##  - Rescale variables?
```

From the `anova` test, we see that `lmer.model.5` is not significantly different from `lmer.model.4`, so we remove the random effect of `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` in `lmer.model.5`.

```
## Data: df.chronic
## Models:
## lmer.model.4: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
## lmer.model.5: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
##              npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## lmer.model.4   11 27880 27942 -13929    27858
## lmer.model.5   12 27881 27949 -13929    27857 1.3565  1     0.2442
```

Next, we will add the random effect of `Home Health Agency Visits per Decedent during the Last Six Months of Life` on `Hospital Name` level to the model, which will make the model `lmer.model.6`.

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
```

```
## Formula:
## `Number of deaths among chronically ill patients assigned to hospital` ~
##     1 + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
##         (1 | State) + (0 + `Other spending per Decedent during the last two years of life` |
##         `Hospital Name`) + (0 + `Standardized FTE physician labor: Ratio MS/PC (calculated)` |
##         `Hospital Name`) + (0 + `Home Health Agency Visits per Decedent during the Last Six Months o
##         `Hospital Name`)
##    Data: df.chronic
##
## REML criterion at convergence: 27878.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.3274 -0.4329 -0.1733  0.2649  4.8241
##
## Random effects:
##  Groups
##  Hospital.Name
##  Hospital.Name.1
##  Hospital.Name.2
##  State
##  Residual
##  Name
##  `Home Health Agency Visits per Decedent during the Last Six Months of Life`
##  `Standardized FTE physician labor: Ratio MS/PC (calculated)`
##  `Other spending per Decedent during the last two years of life`
##  (Intercept)
##
##  Variance  Std.Dev.
##  5.652e-03   0.07518
##  9.355e+03  96.72087
##  1.471e-02   0.12129
##  1.153e+03  33.95347
##  1.683e+04 129.72964
## Number of obs: 2066, groups:  Hospital Name, 2030; State, 51
##
## Fixed effects:
##                                                                              Estimate
## (Intercept)                                                                 1.715e+01
## `Other spending per Decedent during the last two years of life`             9.491e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  1.471e-02
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                1.288e+02
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  4.116e-02
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`  -2.900e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  3.164e-02
##                                                                            Std. Error
## (Intercept)                                                                 2.325e+01
## `Other spending per Decedent during the last two years of life`             1.672e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  7.053e-03
```

```
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                    1.210e+01
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  7.152e-03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     1.311e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   8.229e-03
##                                                                                        df
## (Intercept)                                                                     8.627e+02
## `Other spending per Decedent during the last two years of life`                 9.242e+02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    1.796e+03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                    1.119e+03
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  1.882e+03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`     5.729e+02
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   8.546e+02
##                                                                                   t value
## (Intercept)                                                                         0.738
## `Other spending per Decedent during the last two years of life`                     5.676
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`        2.086
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                       10.645
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`     5.754
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`       -2.211
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`      3.845
##                                                                                  Pr(>|t|)
## (Intercept)                                                                       0.46083
## `Other spending per Decedent during the last two years of life`                  1.85e-08
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`      0.03709
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                      < 2e-16
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 1.01e-08
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`       0.02743
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`     0.00013
##
## (Intercept)
## `Other spending per Decedent during the last two years of life`                  ***
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`     *
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                     ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`      *
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`    ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##                (Intr) `spDdtltyol `IBIp1DdtLTYoL `FplRM( `&SUDpDdtLSMoL
## `spDdtltyol    -0.185
## `IBIp1DdtLTYoL -0.347  0.001
## `SFTEpl:RM(    -0.425 -0.266      -0.018
## `&SUDpDdtLSMoL -0.438  0.040       0.095          0.022
## `HAVpDdtLSMoL  -0.385 -0.204      -0.021         -0.024  -0.003
## `oDEIHdtLSMoL  -0.245 -0.142       0.024         -0.083   0.064
##                `HAVpDdtLSMoL
## `spDdtltyol
## `IBIp1DdtLTYoL
## `SFTEpl:RM(
## `&SUDpDdtLSMoL
## `HAVpDdtLSMoL
## `oDEIHdtLSMoL  -0.063
```

```
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 2.94736 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```

From the `anova` test, we see that `lmer.model.6` is not significantly different from `lmer.model.4`, so we remove the random effect of `Home Health Agency Visits per Decedent during the Last Six Months of Life` in `lmer.model.6`.

```
## Data: df.chronic
## Models:
## lmer.model.4: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
## lmer.model.6: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
##              npar   AIC   BIC logLik deviance Chisq Df Pr(>Chisq)
## lmer.model.4   11 27880 27942 -13929    27858
## lmer.model.6   12 27882 27950 -13929    27858     0  1          1
```

Next, we will add the random effect of `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` on `Hospital Name` level to the model, which will make the model `lmer.model.7`.

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
## `Number of deaths among chronically ill patients assigned to hospital` ~
##     1 + `Other spending per Decedent during the last two years of life` +
##         `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
##         `Standardized FTE physician labor: Ratio MS/PC (calculated)` +
##         `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` +
##         `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
##         `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
##         (1 | State) + (0 + `Other spending per Decedent during the last two years of life` |
##         `Hospital Name`) + (0 + `Standardized FTE physician labor: Ratio MS/PC (calculated)` |
##         `Hospital Name`) + (0 + `Percent of Decedents Enrolled In Hospice during the Last Six Months
##         `Hospital Name`)
##    Data: df.chronic
##
## REML criterion at convergence: 27934.2
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.5564 -0.3425 -0.1330  0.2161  5.2565
##
## Random effects:
##  Groups
##  Hospital.Name
##  Hospital.Name.1
##  Hospital.Name.2
##  State
##  Residual
##  Name
##  `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`
##  `Standardized FTE physician labor: Ratio MS/PC (calculated)`
##  `Other spending per Decedent during the last two years of life`
##  (Intercept)
```

```
##
##  Variance  Std.Dev.
##  1.517e-03   0.03895
##  1.230e+04 110.91105
##  1.254e-02   0.11199
##  1.176e+04 108.45304
##  1.137e+04 106.63033
## Number of obs: 2066, groups:  Hospital Name, 2030; State, 51
##
## Fixed effects:
##                                                                                 Estimate
## (Intercept)                                                                    1.103e+01
## `Other spending per Decedent during the last two years of life`                9.321e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   1.691e-02
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   1.424e+02
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 3.985e-02
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`   -5.350e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  3.893e-02
##                                                                               Std. Error
## (Intercept)                                                                    2.746e+01
## `Other spending per Decedent during the last two years of life`                1.741e-02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   6.992e-03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   1.255e+01
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 7.105e-03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    1.429e+00
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  8.766e-03
##                                                                                      df
## (Intercept)                                                                    5.310e+01
## `Other spending per Decedent during the last two years of life`                9.988e+02
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`   1.784e+03
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   1.301e+03
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 1.752e+03
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    7.396e+02
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  1.193e+03
##                                                                               t value
## (Intercept)                                                                     0.402
## `Other spending per Decedent during the last two years of life`                 5.353
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`    2.418
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   11.349
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`  5.609
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    -3.745
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`   4.441
##                                                                               Pr(>|t|)
## (Intercept)                                                                   0.689534
## `Other spending per Decedent during the last two years of life`               1.07e-07
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  0.015709
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                   < 2e-16
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` 2.37e-08
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`   0.000195
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  9.79e-06
##
## (Intercept)
## `Other spending per Decedent during the last two years of life`               ***
## `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`  *
```

```
## `Standardized FTE physician labor: Ratio MS/PC (calculated)`                    ***
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life` ***
## `Home Health Agency Visits per Decedent during the Last Six Months of Life`    ***
## `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`  ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##                (Intr) `spDdtltyol `IBIp1DdtLTYoL `FplRM( `&SUDpDdtLSMoL
## `spDdtltyol    -0.156
## `IBIp1DdtLTYoL -0.285  0.020
## `SFTEpl:RM(    -0.338 -0.254      -0.021
## `&SUDpDdtLSMoL -0.360  0.033       0.107          0.011
## `HAVpDdtLSMoL  -0.322 -0.204      -0.048         -0.074  -0.020
## `oDEIHdtLSMoL  -0.201 -0.171       0.012         -0.103   0.067
##                `HAVpDdtLSMoL
## `spDdtltyol
## `IBIp1DdtLTYoL
## `SFTEpl:RM(
## `&SUDpDdtLSMoL
## `HAVpDdtLSMoL
## `oDEIHdtLSMoL  -0.025
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
## optimizer (nloptwrap) convergence code: 0 (OK)
## unable to evaluate scaled gradient
## Model failed to converge: degenerate  Hessian with 1 negative eigenvalues
```

From the `anova` test, we see that `lmer.model.7` is not significantly different from `lmer.model.4`, so we remove the random effect of `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` in `lmer.model.7`.

```
## Data: df.chronic
## Models:
## lmer.model.4: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
## lmer.model.7: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other sp
##              npar   AIC   BIC logLik deviance  Chisq Df Pr(>Chisq)
## lmer.model.4   11 27880 27942 -13929    27858
## lmer.model.7   12 27882 27950 -13929    27858 0.1268  1     0.7217
```

Now, we find the optimal model is `lmer.model.4`, which includes fixed effect of `Other spending per Decedent during the last two years of life`, `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`, `Standardized FTE physician labor: Ratio MS/PC (calculated)`, `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`, `Home Health Agency Visits per Decedent during the Last Six Months of Life`, and `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`, and random effect of `Other spending per Decedent during the last two years of life` and `Standardized FTE physician labor: Ratio MS/PC (calculated)` on `Hospital Name` level, and an intercept on `State` level.

Model Comparison

```
## Data: df.chronic
## Models:
## lmer.model.best: `Number of deaths among chronically ill patients assigned to hospital` ~ 1 + `Other
## glm.model.best: `Number of deaths among chronically ill patients assigned to hospital` ~ State + `Ot
```

```
##                 npar   AIC   BIC logLik deviance Chisq Df Pr(>Chisq)
## lmer.model.best   11 27880 27942 -13929    27858
## glm.model.best    58 27984 28310 -13934    27868     0 47          1
```

- Fixed effects:

```
##                                                                  (Intercept)
##                                                                17.10475820
##                `Other spending per Decedent during the last two years of life`
##                                                                 0.09462250
##   `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`
##                                                                 0.01474744
##                   `Standardized FTE physician labor: Ratio MS/PC (calculated)`
##                                                               128.98274265
## `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`
##                                                                 0.04117222
##    `Home Health Agency Visits per Decedent during the Last Six Months of Life`
##                                                                -2.91065499
##  `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`
##                                                                 0.03167263
```

- Random effects for first 5 hospitals:

```
## [1] 7397.314
```

```
## [1] 42228.38
```

```
##  [1] "Hospital Name"
##  [2] "State"
##  [3] "Region"
##  [4] "Number of deaths among chronically ill patients assigned to hospital"
##  [5] "Other spending per Decedent during the last two years of life"
##  [6] "Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life"
##  [7] "High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life"
##  [8] "Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life"
##  [9] "SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life"
## [10] "Standardized FTE physician labor: Ratio MS/PC (calculated)"
## [11] "Medical & Surgical Unit Days per Decedent during the Last Six Months of Life"
## [12] "Home Health Agency Visits per Decedent during the Last Six Months of Life"
## [13] "Percent of Decedents Enrolled In Hospice during the Last Six Months of Life"
## [14] "RE-Standardized FTE physician labor: Ratio MS/PC (calculated)"
## [15] "RE-Other spending per Decedent during the last two years of life"
## [16] "RE-State"
## [17] "predicted"
```

```
##                       Hospital Name State Region
## 1 Southeast Alabama Medical Center    AL  South
## 2    Marshall Medical Center South    AL  South
## 3   Eliza Coffee Memorial Hospital    AL  South
## 4               St. Vincent's East    AL  South
## 5   Dekalb Regional Medical Center    AL  South
## 6    Shelby Baptist Medical Center    AL  South
##   Number of deaths among chronically ill patients assigned to hospital
## 1                                                                  512
## 2                                                                  307
## 3                                                                  469
## 4                                                                  250
```

```
## 5                                                                  122
## 6                                                                  253
##   Other spending per Decedent during the last two years of life
## 1                                                     466.9313
## 2                                                     646.5388
## 3                                                     332.9173
## 4                                                     496.1821
## 5                                                     635.3706
## 6                                                     629.9477
##   Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life
## 1                                                                         49
## 2                                                                        280
## 3                                                                        215
## 4                                                                       1135
## 5                                                                       1168
## 6                                                                        385
##   High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life
## 1                                                                                1780
## 2                                                                                2085
## 3                                                                                1803
## 4                                                                                 326
## 5                                                                                1785
## 6                                                                                  99
##   Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life
## 1                                                                                        1001
## 2                                                                                        1549
## 3                                                                                        1739
## 4                                                                                         386
## 5                                                                                         856
## 6                                                                                        1534
##   SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life
## 1                                                                  270
## 2                                                                 1535
## 3                                                                 1169
## 4                                                                  288
## 5                                                                  608
## 6                                                                  290
##   Standardized FTE physician labor: Ratio MS/PC (calculated)
## 1                                                  0.6663818
## 2                                                  0.5946793
## 3                                                  1.0414696
## 4                                                  0.8385663
## 5                                                  0.7555223
## 6                                                  1.0136276
##   Medical & Surgical Unit Days per Decedent during the Last Six Months of Life
## 1                                                                         1920
## 2                                                                         1589
## 3                                                                         1690
## 4                                                                         1484
## 5                                                                           57
## 6                                                                         1515
##   Home Health Agency Visits per Decedent during the Last Six Months of Life
## 1                                                                 11.919255
## 2                                                                 12.796285
```

```
## 3                                                                    13.289242
## 4                                                                    12.821708
## 5                                                                    16.248522
## 6                                                                     8.532894
##   Percent of Decedents Enrolled In Hospice during the Last Six Months of Life
## 1                                                                        1021
## 2                                                                        1232
## 3                                                                         473
## 4                                                                        1308
## 5                                                                        1749
## 6                                                                        2063
##   RE-Standardized FTE physician labor: Ratio MS/PC (calculated)
## 1                                                      68.57135
## 2                                                      12.38737
## 3                                                      73.20540
## 4                                                      -7.81998
## 5                                                     -26.09497
## 6                                                     -25.32660
##   RE-Other spending per Decedent during the last two years of life RE-State
## 1                                                      0.073174590 22.64353
## 2                                                      0.020510605 22.64353
## 3                                                      0.035638593 22.64353
## 4                                                     -0.007046883 22.64353
## 5                                                     -0.033421371 22.64353
## 6                                                     -0.023971245 22.64353
##   predicted
## 1  327.1627
## 2  269.5832
## 3  342.7398
## 4  266.7509
## 5  184.0411
## 6  297.8816
```

References

[1] https://www.cancer.gov/publications/dictionaries/cancer-terms/def/chronic-disease

[2] https://data.dartmouthatlas.org/eol-chronic/

Code Appendix

```
# https://yihui.org/knitr/options/
knitr::opts_chunk$set(message = FALSE, warning = FALSE, error = FALSE, echo = FALSE,
    fig.pos = "H", fig.align = "center", tidy = TRUE, tidy.opts = list(width.cutoff =
    ↪  80))

library(tidyverse)
library(knitr)
set.seed(123)
library(tidyr)  ## Used to tidy data
library(dplyr)  ## Used to manipulate data
library(gtsummary)
library("caret")
```

```r
library(corrplot)
library(lmerTest)
library(ggplot2)
library(usmap)
library(readxl)
df.chronic <- read_excel("hosp_eolchronic_dead6699ffs_2019.xlsx")

# first convert columns to factor or numeric columns

# relevel: first level is state, second level is region
# https://www.bu.edu/brand/guidelines/editorial-style/us-state-abbreviations/
# https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf Note:
# 1 state is US(unsure), so remove that obervation

# Since the column `Hospice Days per Decedent during the Last Six Months of
# Life` is mislabed, we will remove it from the data

df.chronic <- df.chronic %>%
    select(-`Hospice Days per Decedent during the Last Six Months of Life`)

df.chronic <- df.chronic %>%
    mutate_if(is.character, as.factor) %>%
    mutate(across(.cols = c(`SNF/Long-Term Care Sector Reimbursements per Decedent during
    ↪  the Last Two Years of Life`,
        `Hospice Sector Reimbursements per Decedent during the Last Two Years of Life`,
        `Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life`,
        `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of
        ↪  Life`,
        `Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two
        ↪  Years of Life`,
        `Medical & Surgical Unit Bed Inputs per 1,000 Decedents during the Last Two Years
        ↪  of Life`,
        `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`, ,
        `RNs Required Under Proposed Federal Standards per 1,000 Decedents during the
        ↪  Last Two Years of Life`,
        `High-Intensity ICU Days per Decedent during the Last Six Months of Life`,
        `Intermediate-Intensity ICU Days per Decedent during the Last Six Months of
        ↪  Life`,
        `Medical & Surgical Unit Days per Decedent during the Last Six Months of Life`,
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`),
        ~as.numeric(.))) %>%
    mutate(Region = case_when(State %in% c("CT", "ME", "MA", "NH", "RI", "VT", "NJ",
        "NY", "PA") ~ "Northeast", State %in% c("IN", "IL", "MI", "OH", "WI", "IA",
        "KS", "MN", "MO", "NE", "ND", "SD") ~ "Midwest", State %in% c("DE", "DC",
        "FL", "GA", "MD", "NC", "SC", "VA", "WV", "AL", "KY", "MS", "TN", "AR", "LA",
        "OK", "TX") ~ "South", State %in% c("AZ", "CO", "ID", "NM", "MT", "UT", "NV",
        "WY", "AK", "CA", "HI", "OR", "WA") ~ "West"), Region = factor(Region)) %>%
    filter(State != "US")
# filter(!is.na(Region))

# summary(df.chronic) summary(df.chronic$State) summary(df.chronic$Region)
# check which cols have na values
na_cols <- colnames(df.chronic)[colSums(is.na(df.chronic)) > 0]
```

```r
# check the ratio of NAs in these columns
na_ratio <- colSums(is.na(df.chronic[na_cols]))/nrow(df.chronic)
# na_ratio since `System` has 20% missing values, we are going to remove this
# column
df.chronic <- df.chronic %>%
    select(-System)

# `Ambulance spending per Decedent during the last two years of life` has 0.4%
# missing values, we are going to remove these rows
df.chronic <- df.chronic %>%
    drop_na(`Ambulance spending per Decedent during the last two years of life`)

df.chronic[df.chronic < 0] <- NA
# add check for proportion of zeros in each column
df.chronic <- df.chronic %>%
    drop_na()
#'Hospital Name'
cols_to_drop <- c("HRR", "HRR Name", "Provider ID", "City", "Inpatient Sector
↪  Reimbursements per Decedent during the Last Two Years of Life",
    "Outpatient Sector Reimbursements per Decedent during the Last Two Years of Life",
    "SNF/Long-Term Care Sector Reimbursements per Decedent during the Last Two Years of
    ↪  Life",
    "Home Health Sector Reimbursements per Decedent during the Last Two Years of Life",
    "Hospice Sector Reimbursements per Decedent during the Last Two Years of Life",
    "Reimbursements for Durable Medical Equipment per Decedent during the Last Two Years
    ↪  of Life",
    "Ambulance spending per Decedent during the last two years of life", "Part B Spending
    ↪  for Evaluation & Management per Decedent during the Last Two Years of Life",
    "Part B Spending for Procedures per Decedent during the Last Two Years of Life",
    "Part B Spending for Imaging per Decedent during the Last Two Years of Life",
    "Part B Spending for Tests per Decedent during the Last Two Years of Life", "Other
    ↪  Part B spending per Decedent during the last two years of life",
    "Inpatient Days per Decedent during the Last Two Years of Life", "Reimbursements per
    ↪  patient day (calculated)",
    "Reimbursements per Day: Ratio to US Average (calculated)", "Hospital reimbursements
    ↪  per Decedent during the last two years of life",
    "Payments per physician visit (calculated)", "Payments for physician visits per
    ↪  Decedent during the last two years of life",
    "Physician Visits per Decedent during the Last Two Years of Life", "Payments per
    ↪  visit: Ratio to US Average (calculated)",
    "FTE Physician Labor Inputs per 1,000 Decedents during the Last Two Years of Life",
    "FTE Medical Specialist Labor Inputs per 1,000 Decedents during the Last Two Years of
    ↪  Life",
    "FTE Primary Care Physician Labor Inputs per 1,000 Decedents during the Last Two
    ↪  Years of Life",
    "Average Co-Payments for Physician Services per Decedent during the Last Two Years of
    ↪  Life",
    "Average Co-Payments for Durable Medical Equipment per Decedent during the Last Two
    ↪  Years of Life",
    "Percent of Deaths Occurring In Hospital", "Percent of Deaths Associated With ICU
    ↪  Admission",
    "Physician Visits per Decedent during the Last Six Months of Life", "Medical
    ↪  Specialist Visits per Decedent during the Last Six Months of Life",
```

```
    "Primary Care Visits per Decedent during the Last Six Months of Life", "Percent of
    ↪  Decedents Seeing 10 or More Different Physicians during the Last Six Months of
    ↪  Life")

df.chronic <- df.chronic %>%
    select(-cols_to_drop)
plot_correlation <- function(df) {
    dat <- as.matrix(df)
    dimnames(dat) <- list(rep("", ncol(dat)), rep("", ncol(dat)))
    dat[upper.tri(dat)] <- 0

    corrplot(dat, type = "lower", title = "Correlation Plot", cex.main = 0.7)
    # corrplot(dat, type = 'lower' , title='Correlation Plot', mar=c(0,0,0,0),
    # cex.main=0.7, number.cex=0.7, tl.cex = 0.7, cl.cex = 0.7)
}
df.numeric <- df.chronic %>%
    select_if(is.numeric)
df.cat <- df.chronic %>%
    select_if(is.factor)

cor.df.numeric <- cor(df.numeric, use = "complete.obs")
plot_correlation(cor.df.numeric)
# remove highly correlated variables
hc <- findCorrelation(cor.df.numeric, cutoff = 0.3)
hc <- sort(hc)
df.numeric <- df.numeric[, -c(hc)]

cor.df.numeric <- cor(df.numeric, use = "complete.obs")
plot_correlation(cor.df.numeric)

# combine it with categorical variables
df.cat <- df.chronic %>%
    select_if(is.factor)

df.chronic <- cbind(df.cat, df.numeric)

col.df <- colnames(df.chronic)
col.df
state.summ <- df.chronic %>%
    group_by(State) %>%
    summarise(total = sum(`Number of deaths among chronically ill patients assigned to
    ↪  hospital`,
        na.rm = T)) %>%
    rename(state = State)

plot_usmap(data = state.summ, values = "total", lines = "white") +
↪   scale_fill_continuous(name = "total",
    low = "blue", high = "red", label = scales::comma) + theme(legend.position = "right")
    ↪  +
    labs(title = "Total Chronic Deaths by State")


library(kableExtra)
```

```r
overall_summary <- df.chronic %>%
    group_by(Region, State) %>%
    summarise(n = (length(`Number of deaths among chronically ill patients assigned to
    ↪  hospital`) -
        sum(is.na(`Number of deaths among chronically ill patients assigned to
        ↪  hospital`))),
        total = sum(`Number of deaths among chronically ill patients assigned to
        ↪  hospital`,
            na.rm = T), mean = round(mean(`Number of deaths among chronically ill
            ↪  patients assigned to hospital`,
            na.rm = T), 3), sd = round(sd(`Number of deaths among chronically ill
            ↪  patients assigned to hospital`,
            na.rm = T), 3), median = round(median(`Number of deaths among chronically ill
            ↪  patients assigned to hospital`,
            na.rm = T), 3), min = round(min(`Number of deaths among chronically ill
            ↪  patients assigned to hospital`,
            na.rm = T), 3), max = round(max(`Number of deaths among chronically ill
            ↪  patients assigned to hospital`,
            na.rm = T), 3)) %>%
    ungroup()

# output table for overall averages
overall_summary %>%
    mutate_all(linebreak) %>%
    kbl(caption = "Summary of Number of deaths", col.names = linebreak(c("Region",
        "State", "N", "Total", "Mean", "SD", "Median", "Min", "Max")), booktabs = T,
        escape = F, align = "c") %>%
    kable_styling(full_width = FALSE, latex_options = c("hold_position"))

# overall_summary
df.chronic %>%
    group_by(State) %>%
    summarise(var_dead = var(`Number of deaths among chronically ill patients assigned to
    ↪  hospital`)) %>%
    ggplot(aes(x = State, y = var_dead)) + geom_bar(stat = "identity") + labs(title =
    ↪  "Variance of Number of deaths by States",
    x = "States", y = "Variance of Number of deaths") + theme_minimal() +
    ↪  theme(axis.text.x = element_text(angle = 90,
    hjust = 1))
df.chronic %>%
    group_by(Region) %>%
    summarise(var_dead = var(`Number of deaths among chronically ill patients assigned to
    ↪  hospital`)) %>%
    ggplot(aes(x = Region, y = var_dead)) + geom_bar(stat = "identity") + labs(title =
    ↪  "Variance of Number of deaths by Region",
    x = "States", y = "Variance of Number of Region") + theme_minimal()
df.summary.region <- df.chronic %>%
    select(-c(State, `Hospital Name`)) %>%
    tbl_summary(missing = "no", by = Region, type = list(where(is.numeric) ~
    ↪  "continuous"),
        statistic = list(all_continuous() ~ "{mean} ({sd})")) %>%
    add_p() %>%
```

```
    modify_caption("Summary of Variables by Region")
df.summary.region
df.summary.state <- df.chronic %>%
    select(-c(Region, `Hospital Name`)) %>%
    tbl_summary(missing = "no", by = State, type = list(where(is.numeric) ~
    ↪  "continuous"),
        statistic = list(all_continuous() ~ "{mean} ({sd})")) %>%
    add_p() %>%
    modify_caption("Summary of Variables by State")
df.summary.state
library(lme4)
m1 <- lmer(`Number of deaths among chronically ill patients assigned to hospital` ~
    1 + (1 | State), data = df.chronic)
summ1 <- summary(m1)
VarCorr(m1)
summ1$coefficients
m2 <- lmer(`Number of deaths among chronically ill patients assigned to hospital` ~
    1 + (1 | Region), data = df.chronic)
summ2 <- summary(m2)
VarCorr(m2)
summ2$coefficients
AIC(m1, m2)
glm.model.1 <- glm(`Number of deaths among chronically ill patients assigned to hospital`
↪  ~
    State + `Other spending per Decedent during the last two years of life` + `Total ICU
↪  Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of
        ↪  Life` +
        `Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two
        ↪  Years of Life` +
        `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`,
    data = df.chronic)

summary(glm.model.1)
# remove `Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the
# Last Two Years of Life` from glm.model.1

glm.model.2 <- glm(`Number of deaths among chronically ill patients assigned to hospital`
↪  ~
    State + `Other spending per Decedent during the last two years of life` + `Total ICU
↪  Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of
        ↪  Life` +
        `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`,
    data = df.chronic)
```

```r
summary(glm.model.2)
# remove `High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two
# Years of Life` from glm.model.2

glm.model.3 <- glm(`Number of deaths among chronically ill patients assigned to hospital`
↪  ~
    State + `Other spending per Decedent during the last two years of life` + `Total ICU
↪  Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`,
    data = df.chronic)

summary(glm.model.3)
# remove `SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life`
# from glm.model.3

glm.model.4 <- glm(`Number of deaths among chronically ill patients assigned to hospital`
↪  ~
    State + `Other spending per Decedent during the last two years of life` + `Total ICU
↪  Bed Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`,
    data = df.chronic)

summary(glm.model.4)
lmer.model.1 <- lmer(`Number of deaths among chronically ill patients assigned to
↪  hospital` ~
    1 + `Other spending per Decedent during the last two years of life` + `Total ICU Bed
    ↪  Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
        (1 | State), data = df.chronic)

summary(lmer.model.1)
anova(lmer.model.1, glm.model.4)
lmer.model.2 <- lmer(`Number of deaths among chronically ill patients assigned to
↪  hospital` ~
    1 + `Other spending per Decedent during the last two years of life` + `Total ICU Bed
    ↪  Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
        (1 | State) + (0 + `Other spending per Decedent during the last two years of
↪  life` |
```

```
        `Hospital Name`), data = df.chronic)

summary(lmer.model.2)
anova(lmer.model.2, lmer.model.1)

lmer.model.3 <- lmer(`Number of deaths among chronically ill patients assigned to
↪  hospital` ~
    1 + `Other spending per Decedent during the last two years of life` + `Total ICU Bed
    ↪  Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
        (1 | State) + (0 + `Other spending per Decedent during the last two years of
↪  life` |
        `Hospital Name`) + (0 + `Total ICU Bed Inputs per 1,000 Decedents during the Last
        ↪  Two Years of Life` |
        `Hospital Name`), data = df.chronic)

summary(lmer.model.3)

anova(lmer.model.3, lmer.model.2)
lmer.model.4 <- lmer(`Number of deaths among chronically ill patients assigned to
↪  hospital` ~
    1 + `Other spending per Decedent during the last two years of life` + `Total ICU Bed
    ↪  Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
        (1 | State) + (0 + `Other spending per Decedent during the last two years of
↪  life` |
        `Hospital Name`) + (0 + `Standardized FTE physician labor: Ratio MS/PC
        ↪  (calculated)` |
        `Hospital Name`), data = df.chronic)

summary(lmer.model.4)
# model 4 is better than model 2, so we keep the random effect of `Standardized
# FTE physician labor: Ratio MS/PC (calculated)` in lmer.model.4
anova(lmer.model.4, lmer.model.2)
lmer.model.5 <- lmer(`Number of deaths among chronically ill patients assigned to
↪  hospital` ~
    1 + `Other spending per Decedent during the last two years of life` + `Total ICU Bed
    ↪  Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
        (1 | State) + (0 + `Other spending per Decedent during the last two years of
↪  life` |
        `Hospital Name`) + (0 + `Standardized FTE physician labor: Ratio MS/PC
        ↪  (calculated)` |
        `Hospital Name`) + (0 + `Medical & Surgical Unit Days per Decedent during the
        ↪  Last Six Months of Life` |
```

```
        `Hospital Name`), data = df.chronic)

summary(lmer.model.5)
# model 4 is not differnt from model 5, so we remove the random effect of
# `Medical & Surgical Unit Days per Decedent during the Last Six Months of
# Life` in lmer.model.5
anova(lmer.model.5, lmer.model.4)
lmer.model.6 <- lmer(`Number of deaths among chronically ill patients assigned to
↪  hospital` ~
    1 + `Other spending per Decedent during the last two years of life` + `Total ICU Bed
    ↪  Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
        (1 | State) + (0 + `Other spending per Decedent during the last two years of
↪  life` |
        `Hospital Name`) + (0 + `Standardized FTE physician labor: Ratio MS/PC
        ↪  (calculated)` |
        `Hospital Name`) + (0 + `Home Health Agency Visits per Decedent during the Last
        ↪  Six Months of Life` |
        `Hospital Name`), data = df.chronic)

summary(lmer.model.6)
# model 6 and model 4 don't have significant difference, so we remove the
# random effect of `Home Health Agency Visits per Decedent during the Last Six
# Months of Life` in lmer.model.6
anova(lmer.model.6, lmer.model.4)
lmer.model.7 <- lmer(`Number of deaths among chronically ill patients assigned to
↪  hospital` ~
    1 + `Other spending per Decedent during the last two years of life` + `Total ICU Bed
    ↪  Inputs per 1,000 Decedents during the Last Two Years of Life` +
        `Standardized FTE physician labor: Ratio MS/PC (calculated)` + `Medical &
        ↪  Surgical Unit Days per Decedent during the Last Six Months of Life` +
        `Home Health Agency Visits per Decedent during the Last Six Months of Life` +
        `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life` +
        (1 | State) + (0 + `Other spending per Decedent during the last two years of
↪  life` |
        `Hospital Name`) + (0 + `Standardized FTE physician labor: Ratio MS/PC
        ↪  (calculated)` |
        `Hospital Name`) + (0 + `Percent of Decedents Enrolled In Hospice during the Last
        ↪  Six Months of Life` |
        `Hospital Name`), data = df.chronic)

summary(lmer.model.7)
# model 4 is not differnt from model 7, so we remove the random effect of
# `Percent of Decedents Enrolled In Hospice during the Last Six Months of Life`
# in lmer.model.7
anova(lmer.model.7, lmer.model.4)
lmer.model.best <- lmer.model.4
glm.model.best <- glm.model.4
anova(lmer.model.best, glm.model.best)
lmer.model.best.fixef <- fixef(lmer.model.best)
```

```r
lmer.model.best.fixef
lmer.model.best.ranef.hospital <- ranef(lmer.model.best)[[1]]
lmer.model.best.ranef.state <- ranef(lmer.model.best)[[2]]
lmer.model.best.predict <- predict(lmer.model.best)
glm.model.best.predict <- predict(glm.model.best)

# mse for lmer model
lmer.model.best.mse <- mean((df.chronic$`Number of deaths among chronically ill patients
↪  assigned to hospital` -
    lmer.model.best.predict)^2)
print(lmer.model.best.mse)

# mse for glm model
glm.model.best.mse <- mean((df.chronic$`Number of deaths among chronically ill patients
↪  assigned to hospital` -
    glm.model.best.predict)^2)
print(glm.model.best.mse)
df.chronic.filter <- df.chronic %>%
    filter(`Hospital Name` %in% row.names(lmer.model.best.ranef.hospital))

lmer.model.best.ranef.hospital.altered <- lmer.model.best.ranef.hospital %>%
    rename_with(~paste0("RE-", gsub("`", "", .)), everything()) %>%
    rownames_to_column(var = "Hospital Name")

lmer.model.best.ranef.state.altered <- lmer.model.best.ranef.state %>%
    rename(`RE-State` = "(Intercept)") %>%
    rownames_to_column(var = "State")

result_df <- inner_join(df.chronic.filter, lmer.model.best.ranef.hospital.altered,
    by = "Hospital Name")
result_df <- inner_join(result_df, lmer.model.best.ranef.state.altered, by = "State")
result_df$predicted <- predict(lmer.model.best, newdata = df.chronic.filter)

names(result_df)
head(result_df)
```

Table 1: Summary of Number of deaths

Region	State	N	Total	Mean	SD	Median	Min	Max
Midwest	IA	20	6767	338.350	237.690	273.5	107	1010
Midwest	IL	97	30635	315.825	228.837	244.0	85	1518
Midwest	IN	56	17344	309.714	202.822	262.0	89	1086
Midwest	KS	20	6392	319.600	226.715	221.5	89	876
Midwest	MI	63	23033	365.603	236.784	309.0	97	1128
Midwest	MN	21	4998	238.000	140.400	186.0	101	710
Midwest	MO	48	15221	317.104	182.704	244.5	85	822
Midwest	ND	6	1763	293.833	113.788	263.5	202	511
Midwest	NE	16	4526	282.875	207.340	200.5	123	926
Midwest	OH	86	24489	284.756	157.759	241.0	87	932
Midwest	SD	4	1504	376.000	183.888	449.0	103	503
Midwest	WI	38	9070	238.684	144.877	205.5	84	759
Northeast	CT	22	8685	394.773	270.523	324.5	137	1302
Northeast	MA	50	19819	396.380	273.815	304.0	88	1144
Northeast	ME	14	3301	235.786	179.172	158.5	91	666
Northeast	NH	13	3876	298.154	104.489	280.0	154	515
Northeast	NJ	57	23445	411.316	260.557	334.0	84	1044
Northeast	NY	103	37922	368.175	293.662	298.0	80	1740
Northeast	PA	97	29557	304.711	212.975	253.0	84	1387
Northeast	RI	8	2177	272.125	192.287	176.5	99	631
Northeast	VT	5	1521	304.200	193.125	232.0	144	636
South	AL	39	11544	296.000	200.955	273.0	87	1199
South	AR	26	8540	328.462	166.542	314.5	90	777
South	DC	5	1547	309.400	178.825	264.0	100	585
South	DE	6	3201	533.500	561.993	366.0	124	1629
South	FL	140	52136	372.400	276.713	282.0	81	1975
South	GA	62	19092	307.935	186.360	267.5	88	1007
South	KY	39	12078	309.692	248.354	223.0	91	1338
South	LA	33	9630	291.818	190.138	241.0	81	999
South	MD	41	16744	408.390	204.532	422.0	82	959
South	MS	28	9085	324.464	249.489	208.5	80	969
South	NC	67	24565	366.642	269.585	287.0	83	1283
South	OK	34	9952	292.706	239.500	199.0	83	1081
South	SC	36	12636	351.000	234.092	280.0	82	902
South	TN	49	16967	346.265	282.915	266.0	80	1365
South	TX	153	44582	291.386	204.592	230.0	89	1374
South	VA	58	21767	375.293	250.758	304.0	85	1082
South	WV	20	5357	267.850	194.199	195.5	81	860
West	AK	4	811	202.750	133.847	157.0	98	399
West	AZ	37	10942	295.730	149.140	245.0	95	599
West	CA	185	51255	277.054	169.144	229.0	80	1038
West	CO	24	5572	232.167	128.825	229.0	80	534
West	HI	8	1600	200.000	126.203	164.0	91	498
West	ID	9	2635	292.778	161.783	309.0	95	572
West	MT	9	2341	260.111	105.275	243.0	97	413
West	NM	12	2885	240.417	172.280	223.5	80	727
West	NV	17	4868	286.353	161.684	225.0	86	644
West	OR	23	5399	234.739	125.513	212.0	89	523
West	UT	9	2677	297.444	161.726	281.0	111	527
West	WA	45	14572	323.822	166.251	286.0	85	674
West	WY	4	899	224.750	152.902	227.0	84	361

Table 2: Summary of Variables by Region

Characteristic	**Midwest**, N = 475
Number of deaths among chronically ill patients assigned to hospital	307 (201)
Other spending per Decedent during the last two years of life	640 (247)
Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life	1,079 (625)
High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life	1,067 (587)
Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life	1,098 (627)
SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life	1,205 (598)
Standardized FTE physician labor: Ratio MS/PC (calculated)	1.36 (0.47)
Medical & Surgical Unit Days per Decedent during the Last Six Months of Life	1,141 (572)
Home Health Agency Visits per Decedent during the Last Six Months of Life	7.6 (2.9)
Percent of Decedents Enrolled In Hospice during the Last Six Months of Life	1,248 (565)

Table 3: Summary of Variables by State

Characteristic	**AK**, N = 4	**AL*
Number of deaths among chronically ill patients assigned to hospital	203 (134)	296
Other spending per Decedent during the last two years of life	849 (411)	580
Total ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life	725 (338)	961
High-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life	794 (378)	879
Intermediate-Intensity ICU Bed Inputs per 1,000 Decedents during the Last Two Years of Life	1,129 (630)	942
SNF Bed Inputs per 1,000 Dededents during the Last Two Years of Life	83 (21)	630
Standardized FTE physician labor: Ratio MS/PC (calculated)	2.25 (0.51)	0.92
Medical & Surgical Unit Days per Decedent during the Last Six Months of Life	1,209 (785)	1,25
Home Health Agency Visits per Decedent during the Last Six Months of Life	6.2 (1.9)	12.7
Percent of Decedents Enrolled In Hospice during the Last Six Months of Life	137 (153)	1,24