Stat 6227 final project

# Survival Analysis of German Breast Cancer

Group 3

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# Outline

- Background and Dataset
- Model and Analysis
    1. Data Analysis and Model Selection
    2. Regression Diagnostics
    3. Analyze Specific Problems
- Finale

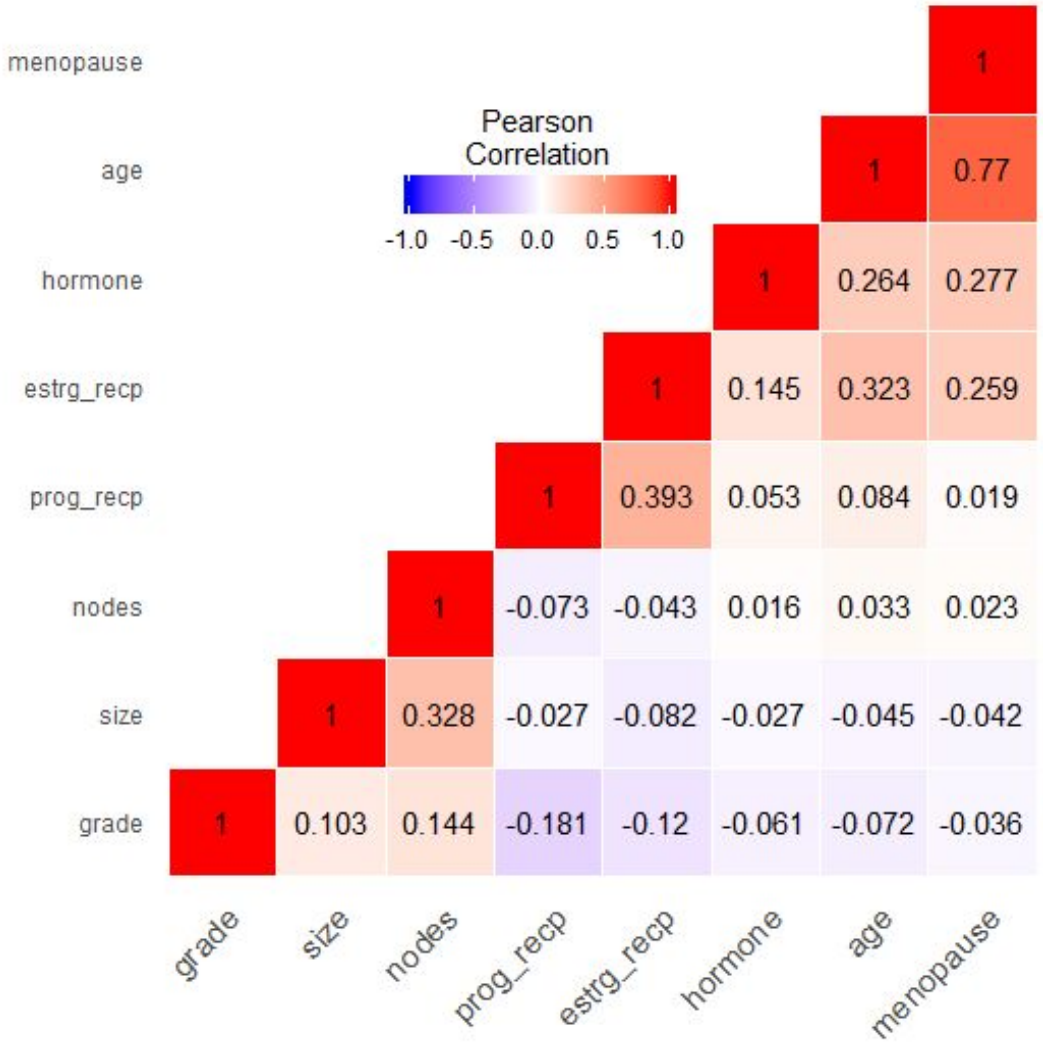
# Background and Dataset

- One prospective study of node-positive breast cancer of the German Breast Cancer Study Group (GBSG)
- Total 686 patients, of whom 299 had an event for recurrence-free survival and 171 died
- Primary outcome variable: overall survival and recurrence-free survival time
- Standard prognostic factors – age, menopausal status, tumour size, tumour grade, number of positive lymph nodes, progesterone (PR) and estrogen receptor (ER) concentrations – were investigated

# Data Explanation

| Variable | Codes/Values | Mean | Sd | Quartiles | | |
|---|---|---|---|---|---|---|
| Numeric: | | | | 25% | 50% | 75% |
| Age at diagnosis | Years | 53.05 | 10.12 | 46 | 53 | 61 |
| Tumor Size | mm | 29.33 | 14.30 | 20 | 25 | 35 |
| # of Nodes involved | 1-51 | 5.01 | 5.48 | 1 | 3 | 7 |
| # of Progesterone Receptors | 0-2380 | 110.00 | 202.33 | 7 | 33 | 132 |
| # of Estrogen Receptors | 0-1144 | 96.25 | 152.08 | 8 | 36 | 114 |
| Categorical: | | | Codes: Number | | | |
| Menopausal status | 1=Yes, 2=No | | Yes: 290; No:396 | | | |
| Hormone Therapy | 1=Yes; 2=No | | Yes: 440; No: 246 | | | |
| **Tumor Grade** | **1-3(G-1, G-2, G-3)** | | **G-1:81; G-2:444; G-3:161** | | | |

# Correlation Heat Map

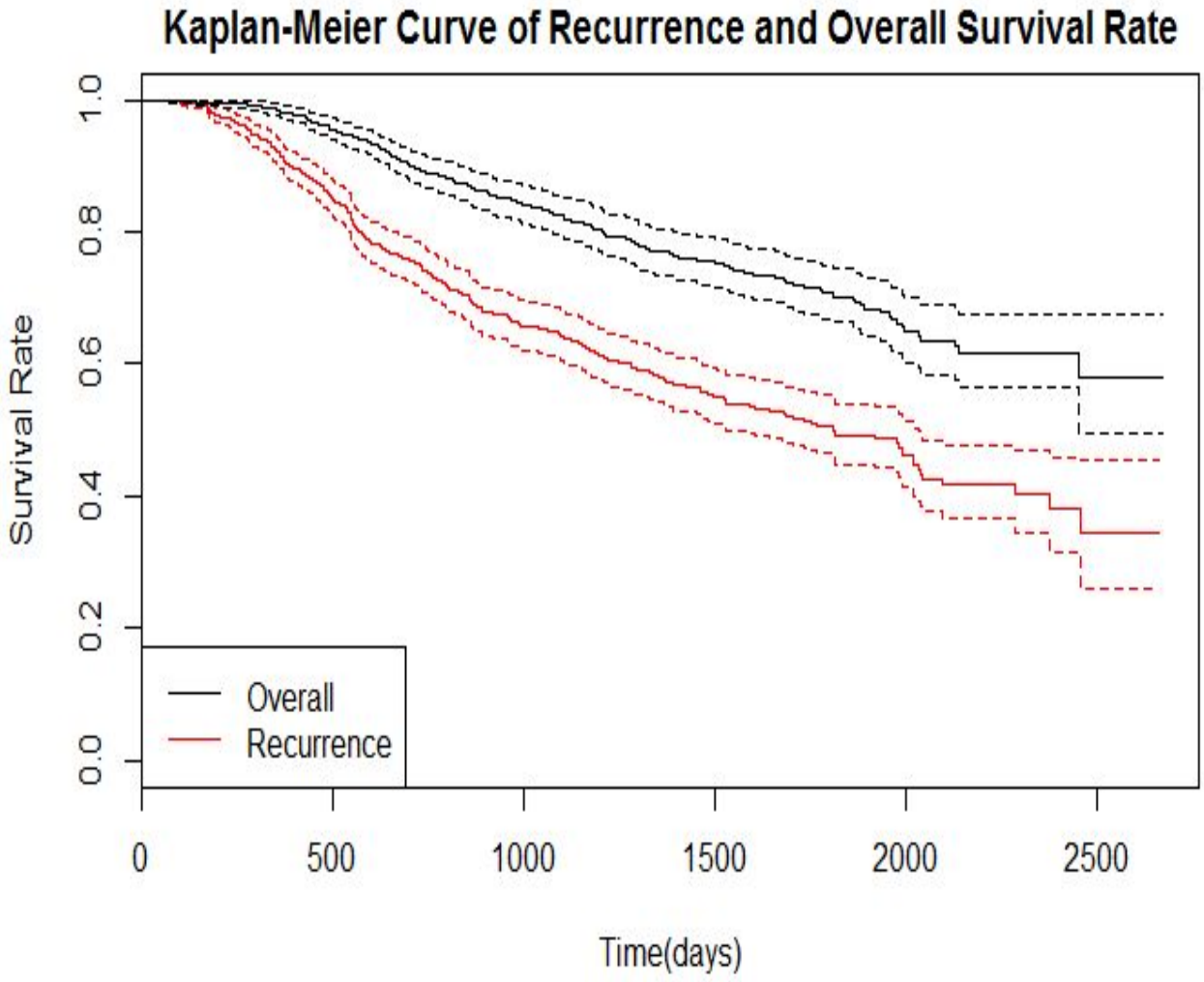


# Study Target:

- Build a prognostic model that predicts the clinical course of a breast cancer patient.
- Modelling the effects of standard prognostic factors
- Evaluate efficacy of hormone therapy and provide treatment advice based on research

# Data Analysis and Model Selection

# K-M estimator for survival rate



# Hypothesis test

- **Menopause:**

$H_0 : S_{\text{pre-menopause}}(t) = S_{\text{post-menopause}}(t)$

$H_a : S_{\text{pre-menopause}}(t) \neq S_{\text{post-menopause}}(t)$

- For overall survival:

| | Q | Var | Z | pNorm |
|---|---|---|---|---|
| 1 | 4.5157e+00 | 4.1591e+01 | 0.70020 | 0.48380 |

- For recurrence free survival:

| | Q | Var | Z | pNorm |
|---|---|---|---|---|
| 1 | 4.5020e+00 | 7.2351e+01 | 0.529281 | 0.59661 |

# Hypothesis test

- **Hormone therapy:**

$$H_0 : S_{treated}(t) = S_{non\text{-}treated}(t)$$
$$H_a : S_{treated}(t) \neq S_{non\text{-}treated}(t)$$

- For overall survival:

```
                Q          Var         Z    pNorm
1 -1.0166e+01  4.0347e+01 -1.60045 0.109498
```

- For recurrence free survival:

```
Call:
survdiff(formula = Surv(rectime, censrec) ~ hormone, data = gbcs,
    rho = 0)

             N Observed Expected (O-E)^2/E (O-E)^2/V
hormone=0 440      205      180      3.37      8.56
hormone=1 246       94      119      5.12      8.56

 Chisq= 8.6  on 1 degrees of freedom, p= 0.00343
```

# Stepwise Cox Model Selection

| | Least AIC | Kept Variables |
|---|---|---|
| Survtime | 1953.89 | Size, grade2, grade3, nodes and prog_recp |
| Rectime | 3485.68 | Hormone0, size, grade2, grade3, nodes and prog_recp |

- For overall survival, size, grade2, grade3, nodes have positive effect on survival rate.
- For recurrence event,  all variables have positive effect.

# Regression Diagnostics

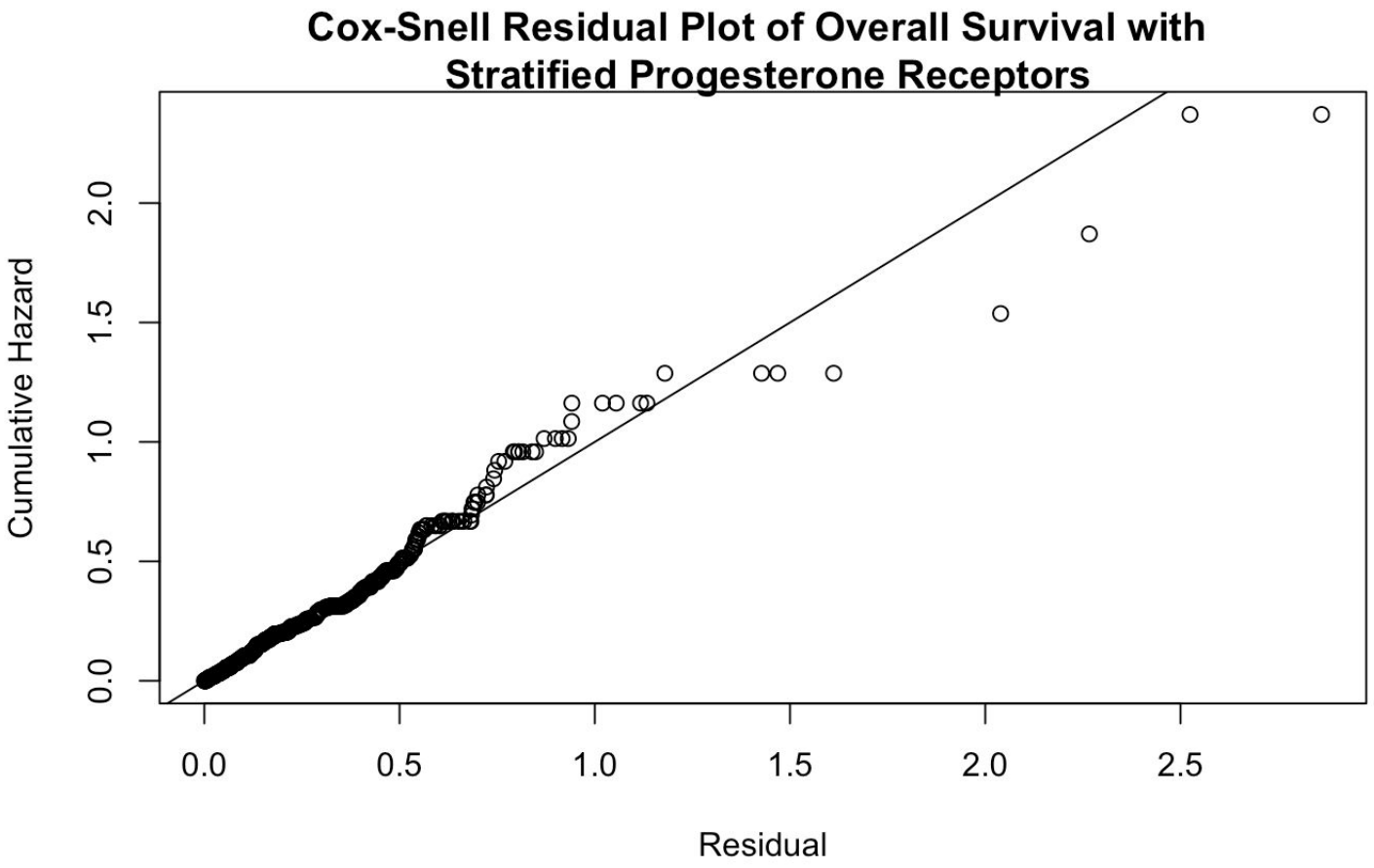
# Overall Survival Model Diagnosis - Proportional Assumption

| | rho | chisq | p |
|---|---|---|---|
| size | -0.03166 | 0.17473 | 0.6759 |
| grade2 | 0.00706 | 0.00861 | 0.9261 |
| grade3 | -0.02751 | 0.13326 | 0.7151 |
| nodes | 0.09030 | 0.91654 | 0.3384 |
| prog_recp | 0.17272 | 8.47595 | 0.0036 |
| GLOBAL | NA | 12.64064 | 0.0270 |

The prog_recp (PR) has p-value < 0.05, it might violate the proportional assumption, so we applied stratified model with

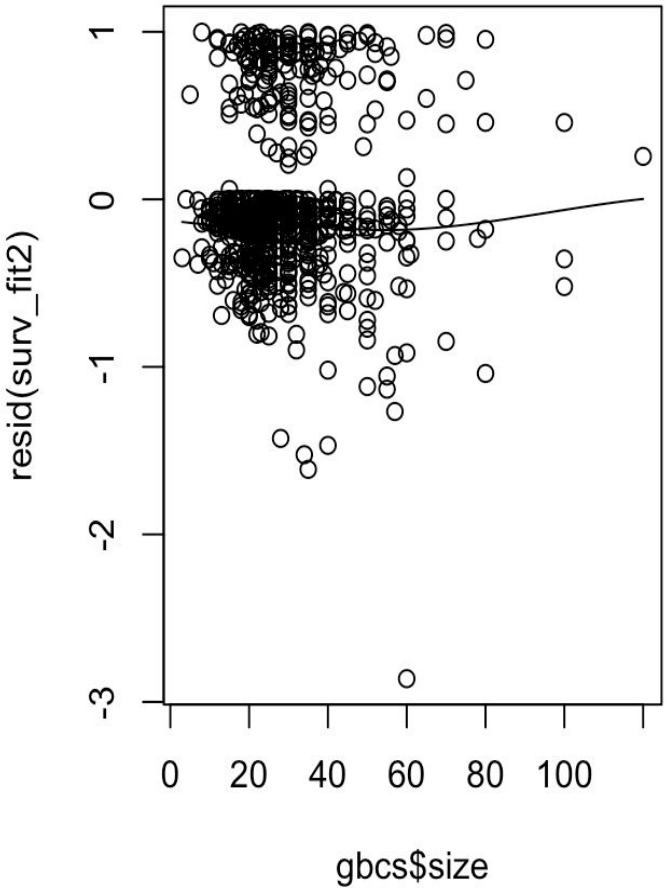
PR level 1: < 20; level 2: [21, 90]; level 3: > 91

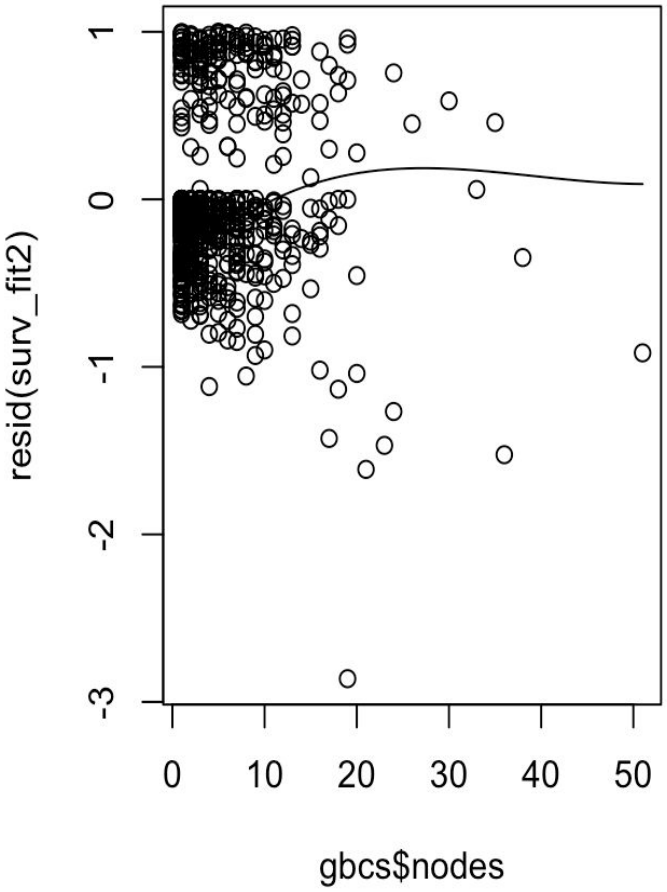
After log-likelihood test, we could not reject the stratified model.



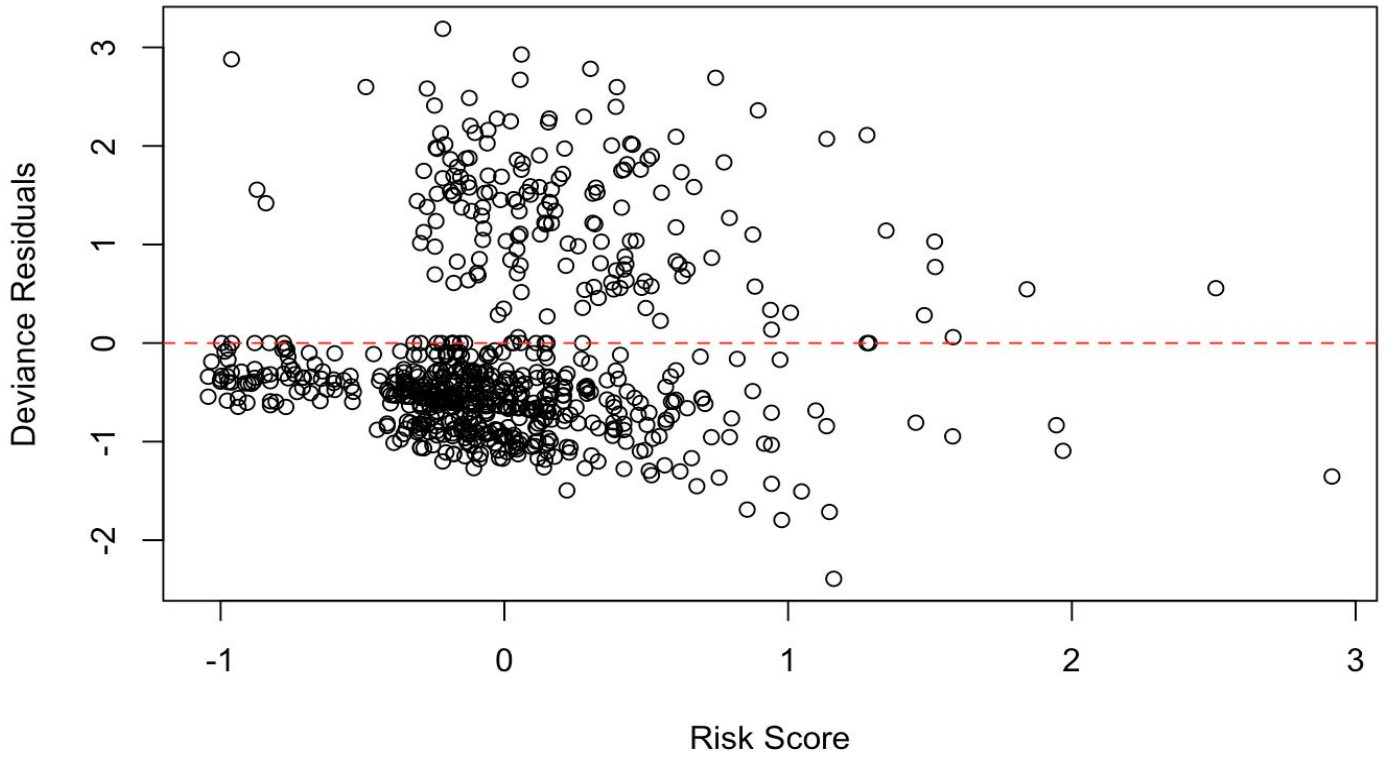

Might consider variable transformation ?

# Martingale Residual Plot



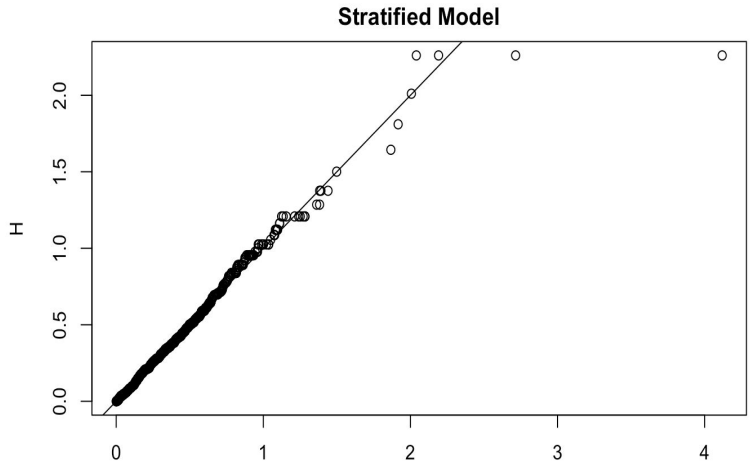
# Deviance Residuals Plot

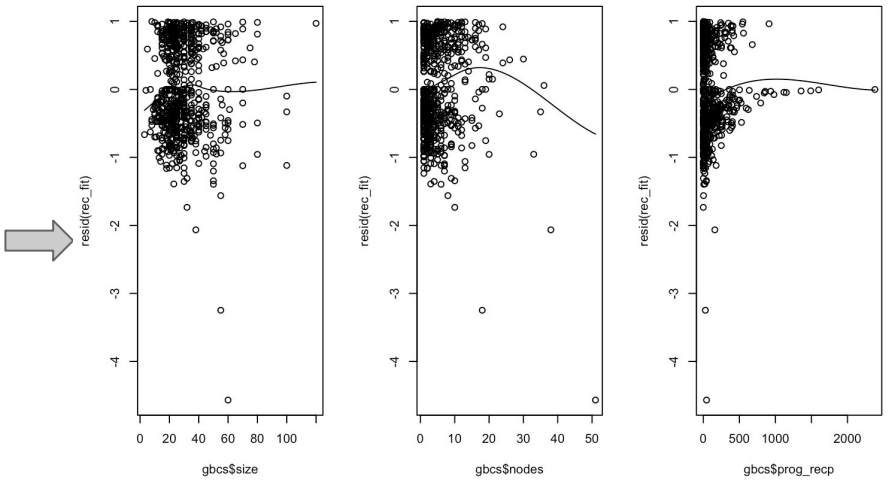


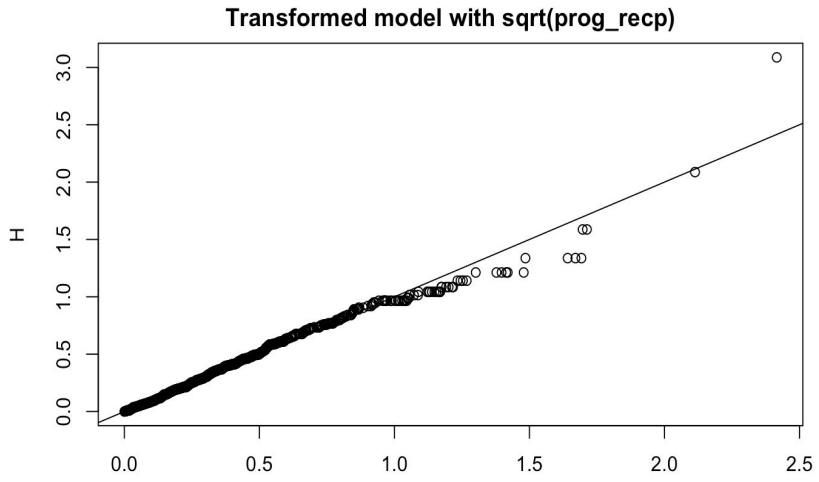

Not very sysmetrix:

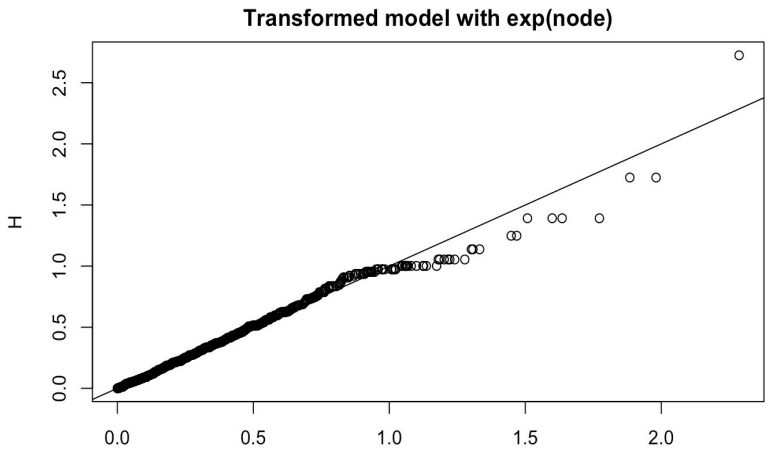
- Too much censoring data (>50%)
- Transformation might needed???

# Recurrence Model Diagnosis



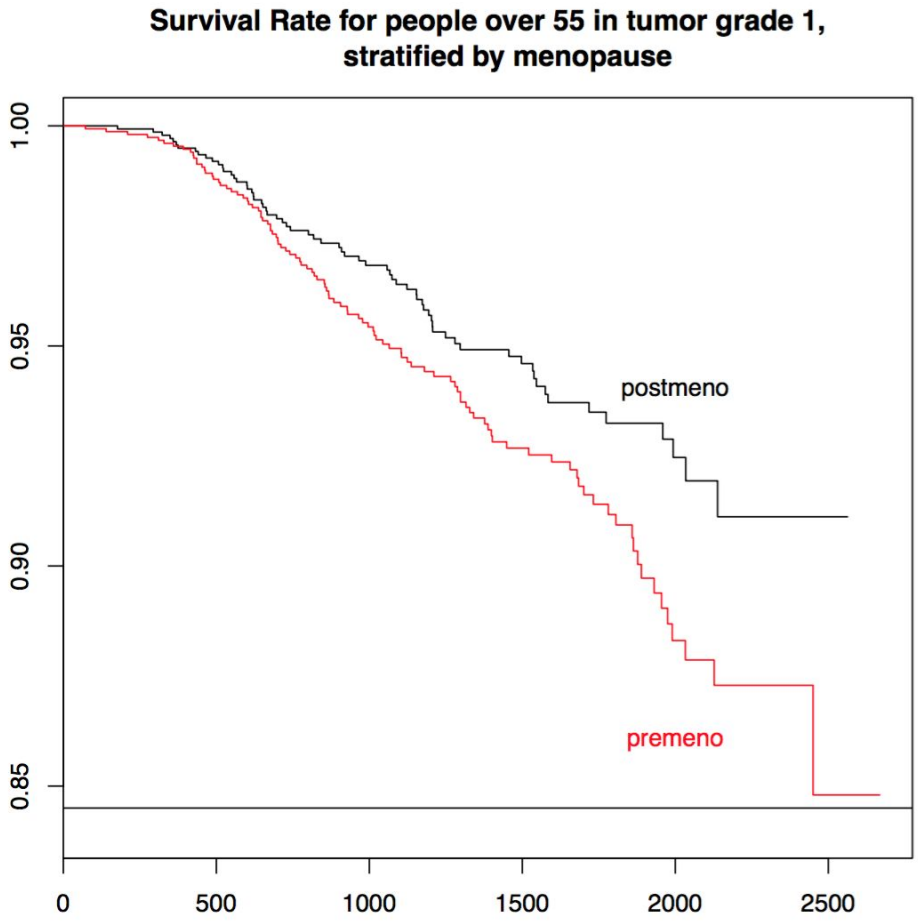



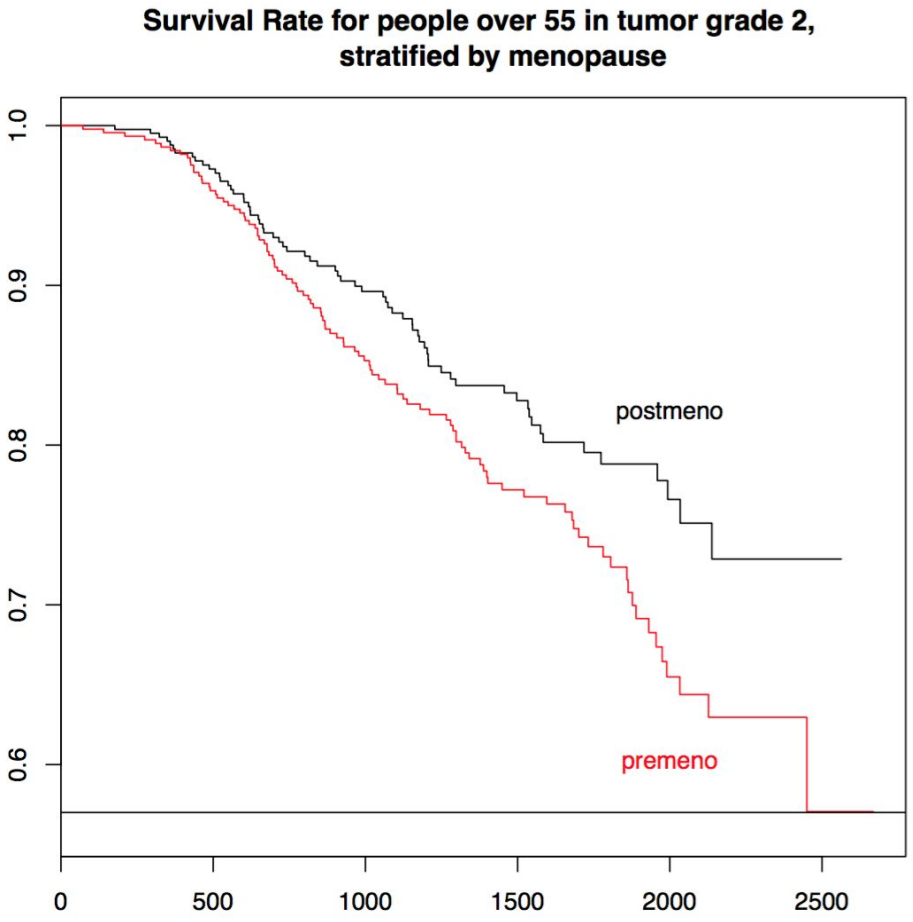
# Analyze Specific Problems

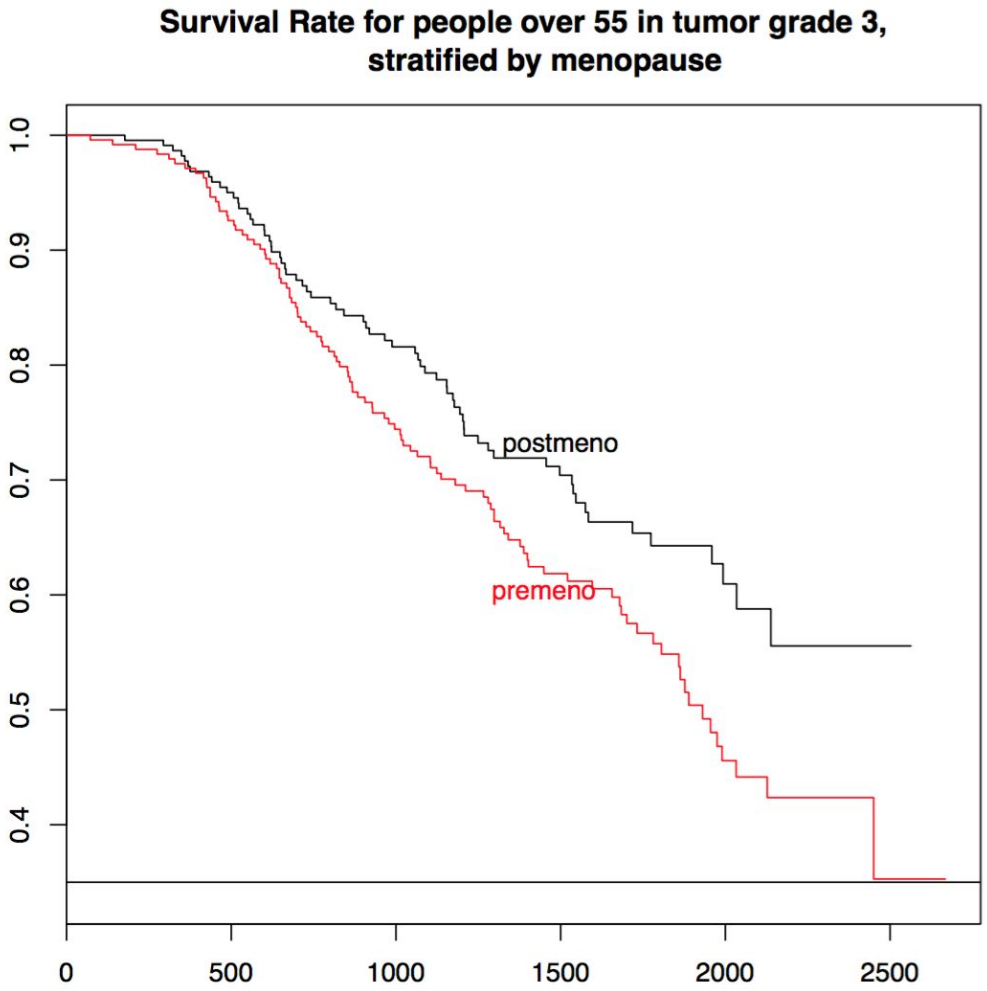
1.

# What is the effect of late menopause on patients who are older than 55 ?

# Age: 55 or older
# Tumor Grade: 1, 2, 3



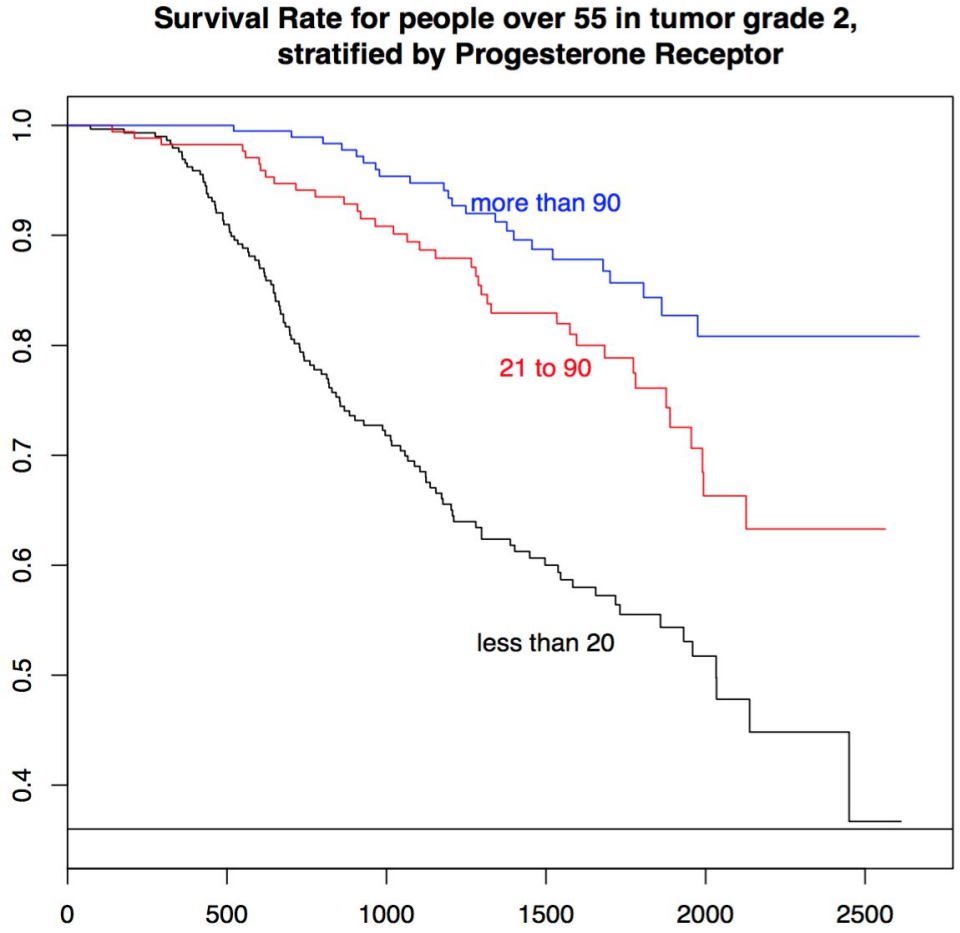


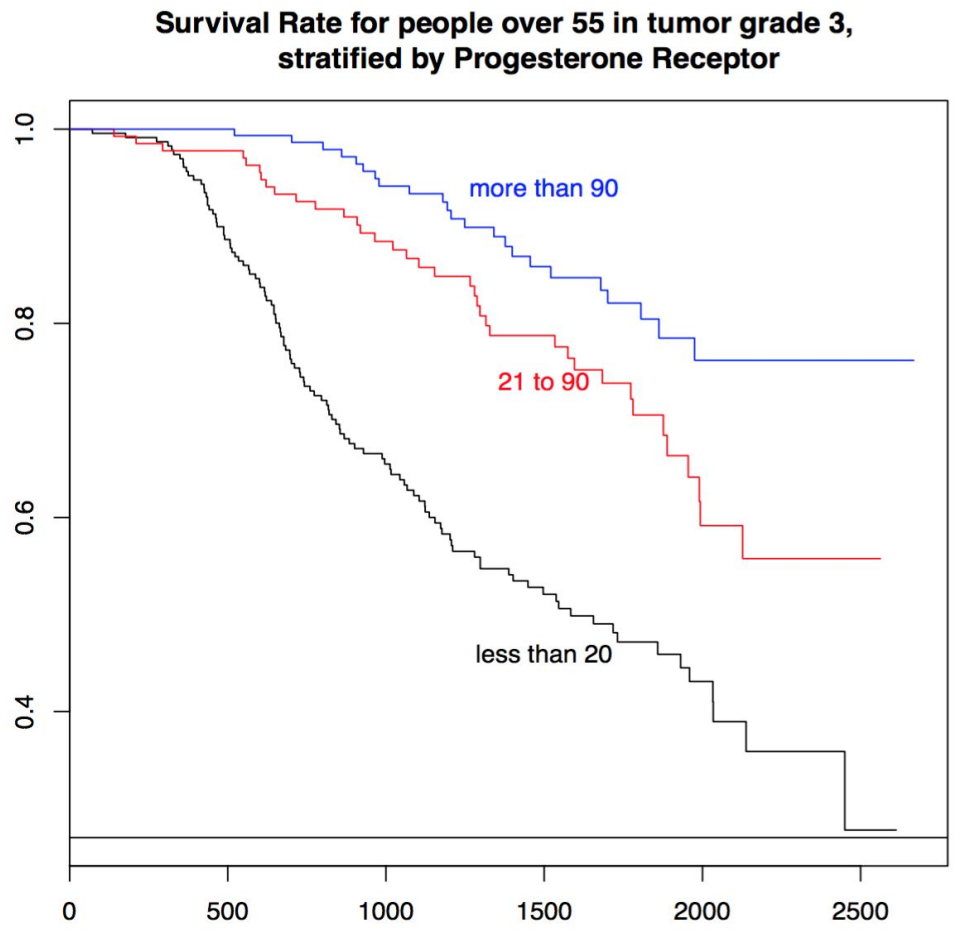

1. The higher tumor grade is, the lower survival rate is.
2. Post Menopause women are safer.

2.

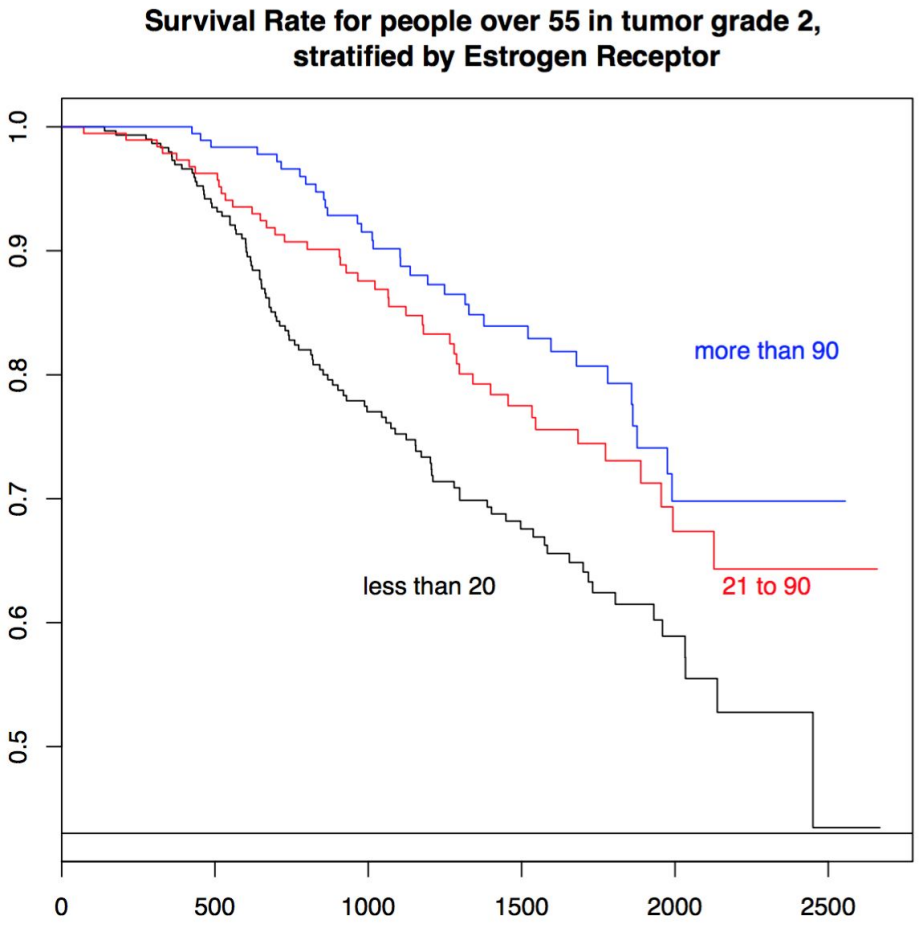
# Does PR or ER work well on curbing Breast Cancer ?

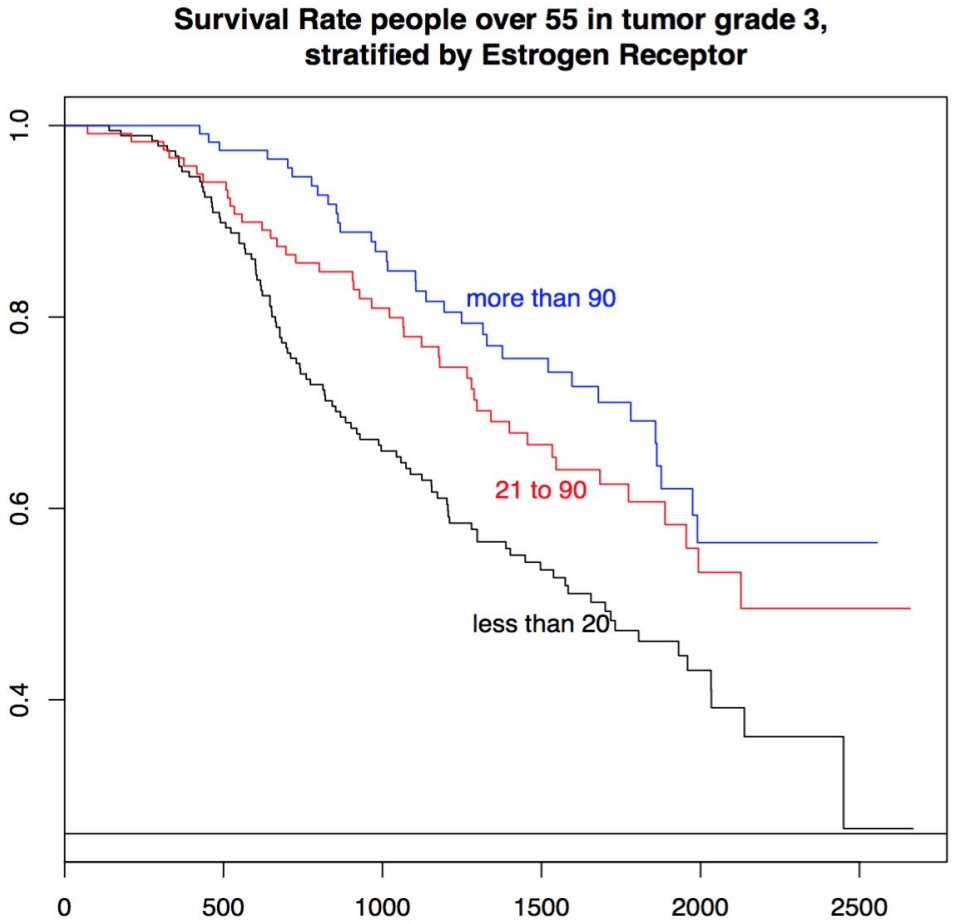
# Age: 55 or older
# Tumor Grade: 2, 3



# Higher receptors repress cancer and improve survival rate.
# Both receptors study lead to same results.

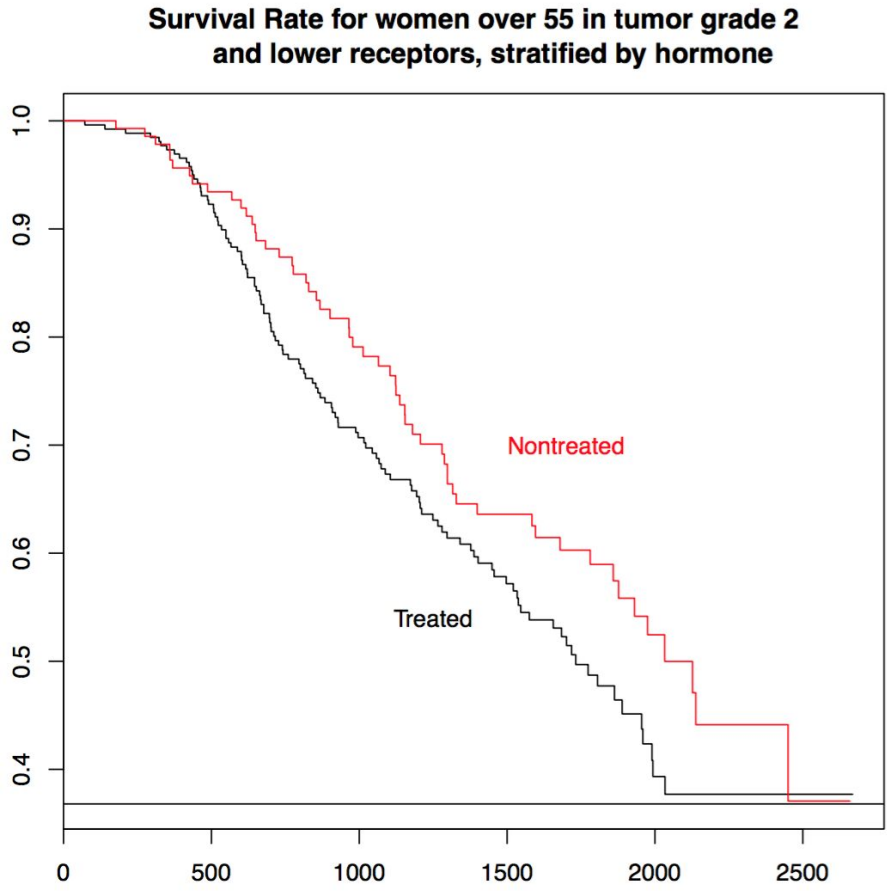


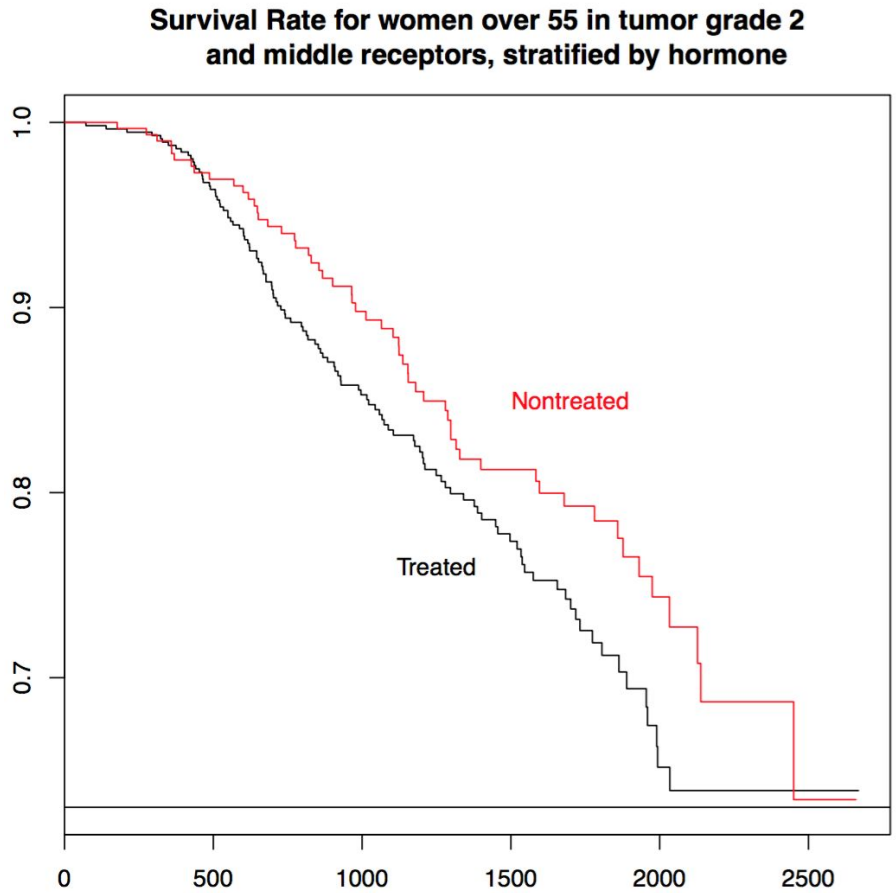



3.

# Is it useful for patients to use hormone therapy on controlling disease ?

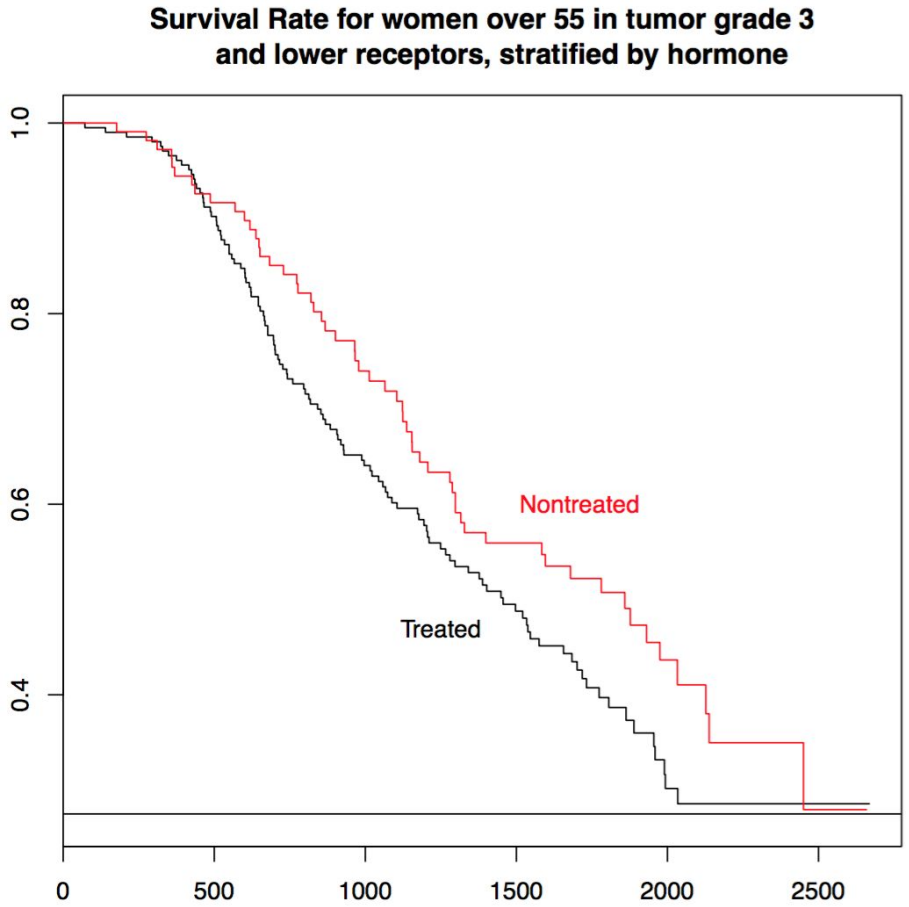
# Age: under 45; over 55  Tumor Grade: 2,3
# Progesterone Receptor: lo:20; 21:90

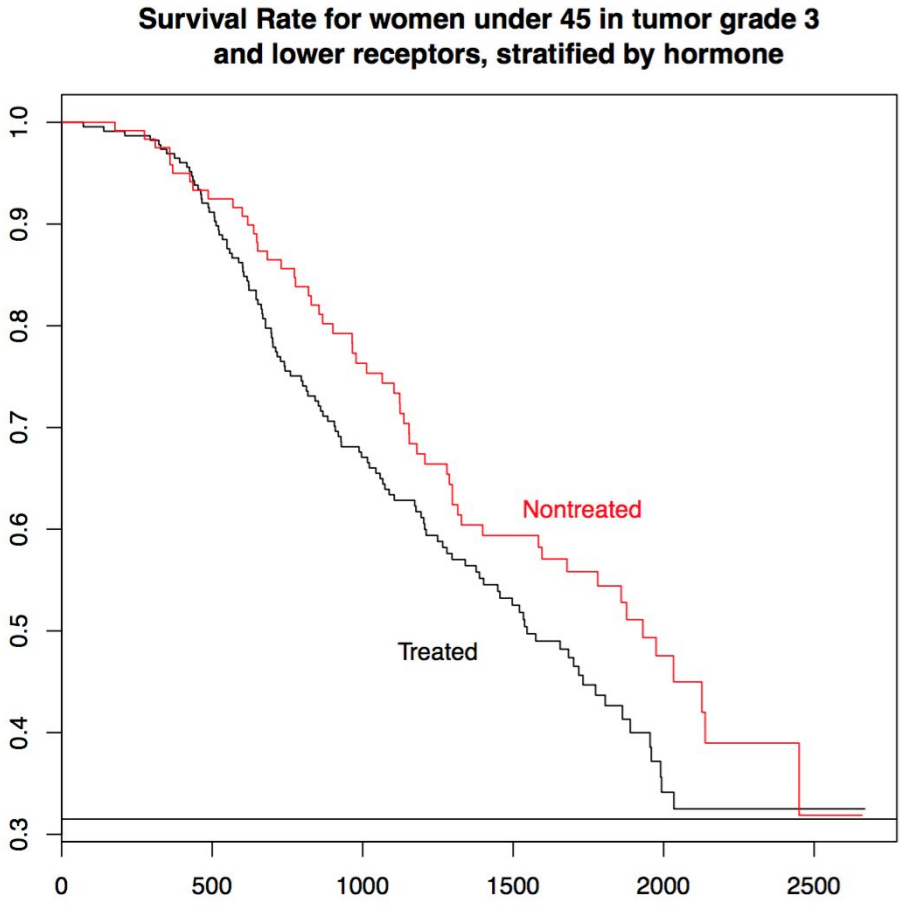



Higher Progesterone Receptor Number does not make hormone therapy work better.

# Serious Tumor Grade and Younger Age do not make the hormone therapy work better




On different conditions,
getting hormone therapy reduces survival rate.

# Finale

1. For the overall survival rate, significant factors are:
   - Tumor size
   - Grade of tumor
   - Number of lymph nodes
   - PR concentrations;

2. For recurrence patients, besides the factors above, hormone therapy might also affect survival rate.

## Tip1

Inquire if pre menopause over 55, otherwise hard to cure cancer;

## Tip2

For receptor-test result positive patients, the hormone therapy is recommended, otherwise they can do chemotherapy.

## Tip3

The efficacy of hormone therapy might vary among different case scenario


Q&A