

(1) Introduction and Aims

A variety of factors may contribute to a physician's ability to provide quality care to patients and influence health outcomes. This is particularly true in the ICU, where patients present with severe and complex disease. Data such as physician level of education, training and feedback from residents and patients are recorded, but it is still unknown which of these factors correlates with patient outcome. Patient demographics must also be considered.

We considered the case study with the following aims:

- Investigate if Physician had a significant effect on patient outcome.
- Produce a model-based physician quality indicator.
- Determine which physician characteristics had a significant effect on patient outcome.

(2) Data Processing

- Calculating the change of SOFA (a measure of organ failure) between admission and discharge from the patient SOFA trajectory data. This measure is denoted as SOFAdelta.
- Obtaining the overall evaluation score from the physician 360-degree evaluation data.
- Taking patient characteristic data at ICU admission and doctor characteristic data as factors.

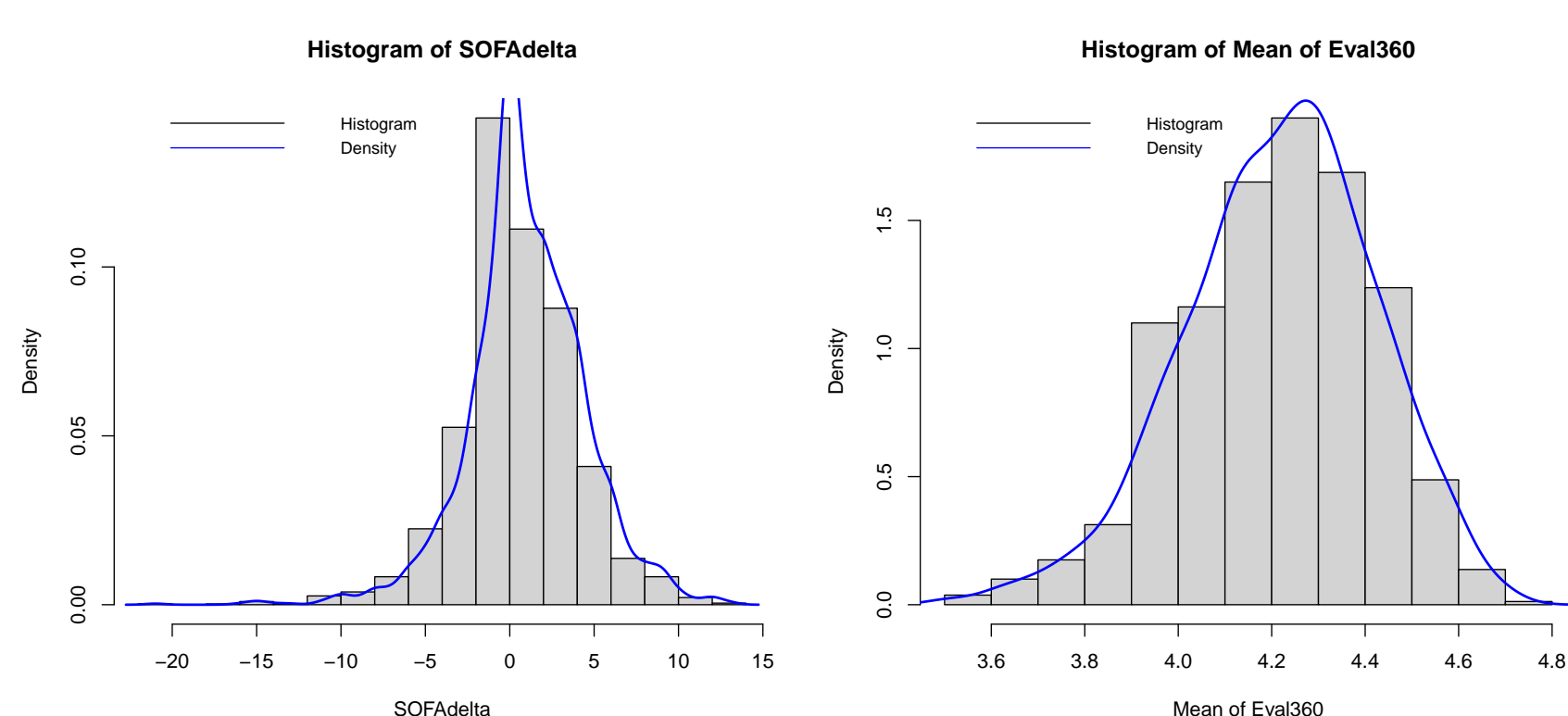


Figure 1 Distributions of SOFAdelta and Mean of Eval360

(3) Confirming Physician Effect on Patient Outcome

We first modelled deltaSOFA as a function of patient characteristics and the identity of their doctor, to determine if attending doctor had an impact on patient outcome.

Backward selection was used to reduce the model.

Examination of the model and residuals revealed skewness of the data and a poor fit using a normal distribution.

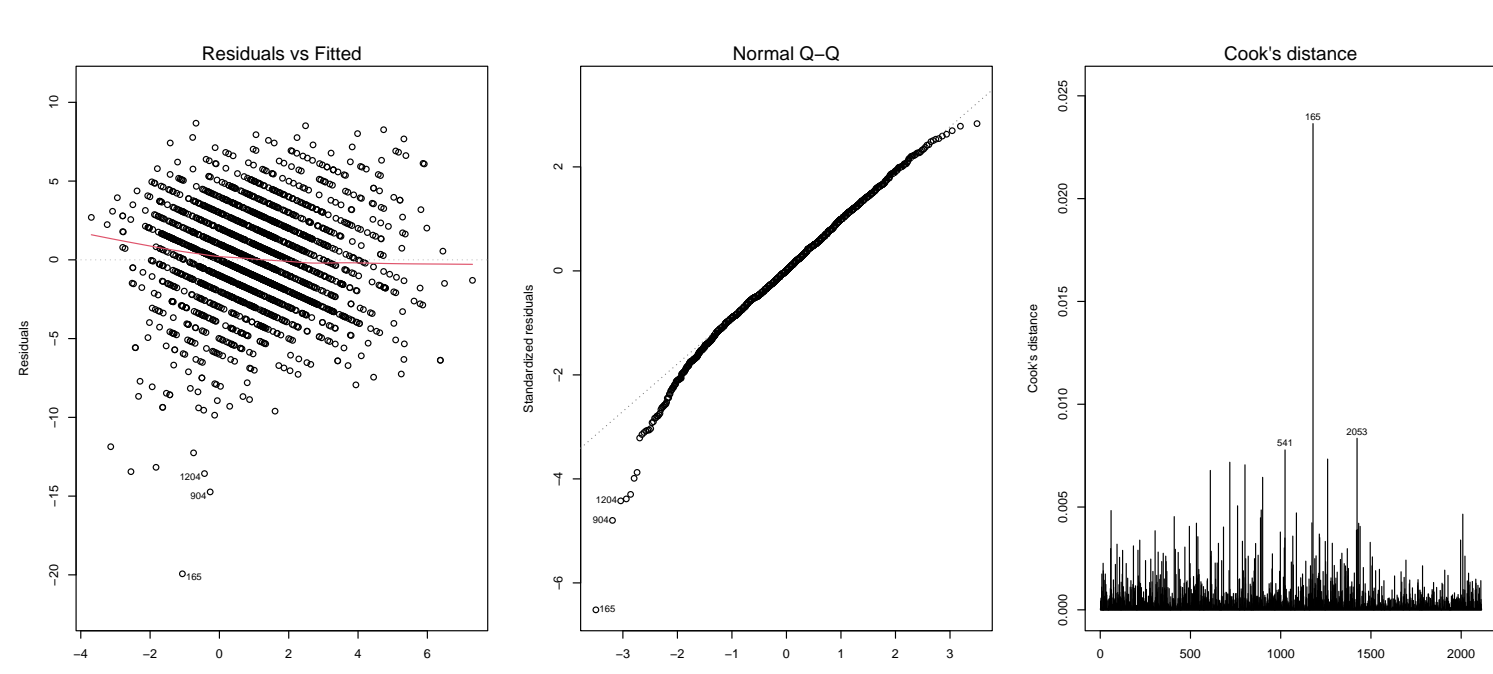


Figure 2 Model Diagnostics for the Linear Model with Physician as a Factor

(4) Improving fit of our model using a Skew-elliptical Distribution

Transformations were of limited use, so we applied a skew-elliptical distribution (a modification on a Gaussian distribution) using the package 'sn'. Transformations of the response were less interpretable and useful that using a skew-elliptical (skew-normal) error in the model.

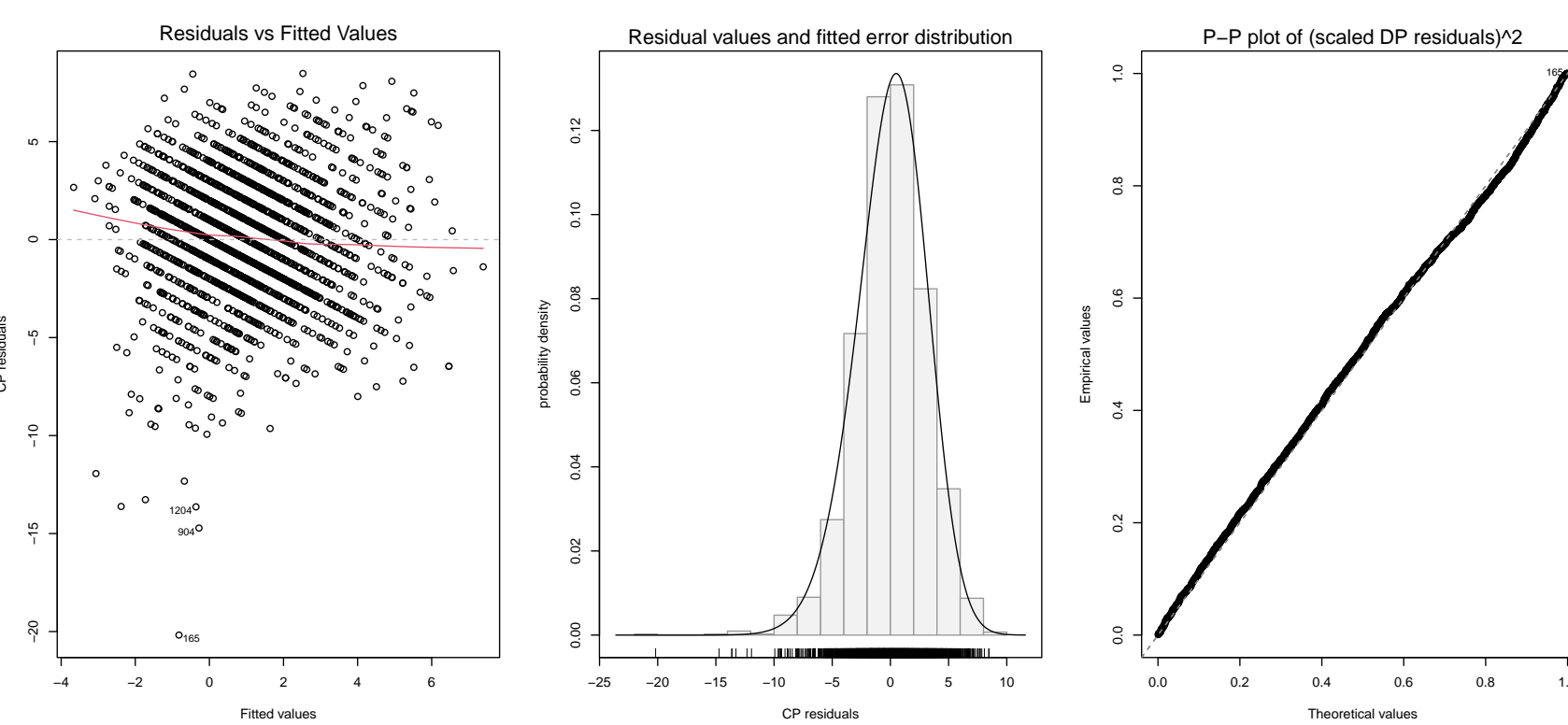


Figure 3 The Residual Check of the Skew Normal Fitted Multivariate Linear Regression

The above residual checking shows a good fit and confirms that physician is indeed relevant to the outcomes of patient.

(5) Physician Quality Indicator

We standardized the physician effect on patient outcome (by dividing the coefficient estimate of doctors by the standard error of that estimate) to use as a quality indicator.

Physician Quality Indicator = Regression Coefficient WRT deltaSOFA / std error of Regression Coefficient

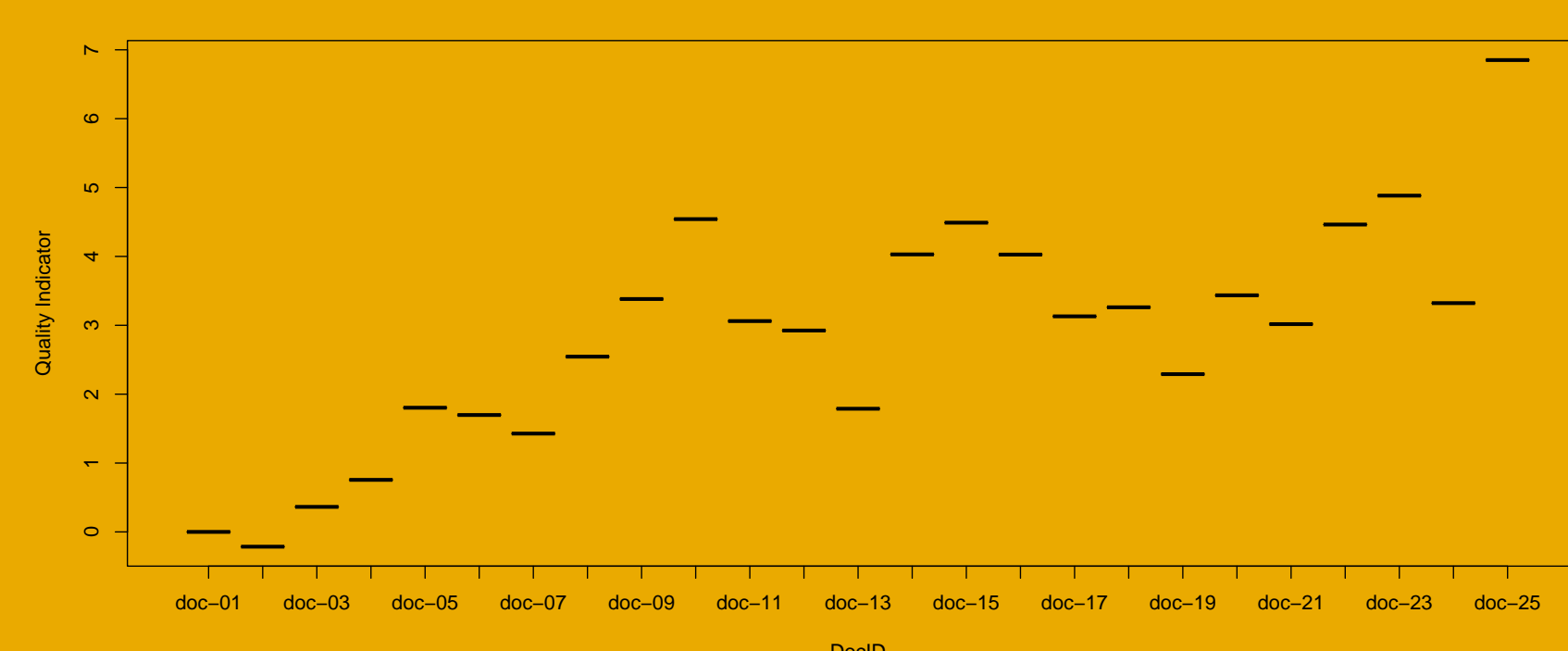


Figure 4 The Plot of Physician Quality Indicators with respect to DocID

(6) Finding Physician Characteristics Influencing Physician Quality Indicator

We used both backward and forward selection to fit a generalized linear model for the second level. AIC improvements were compared by dropping and adding each variable from upper and lower bound variable sets.

By checking the p-value of residual deviance, we conclude that the generalized linear model is fitted well.

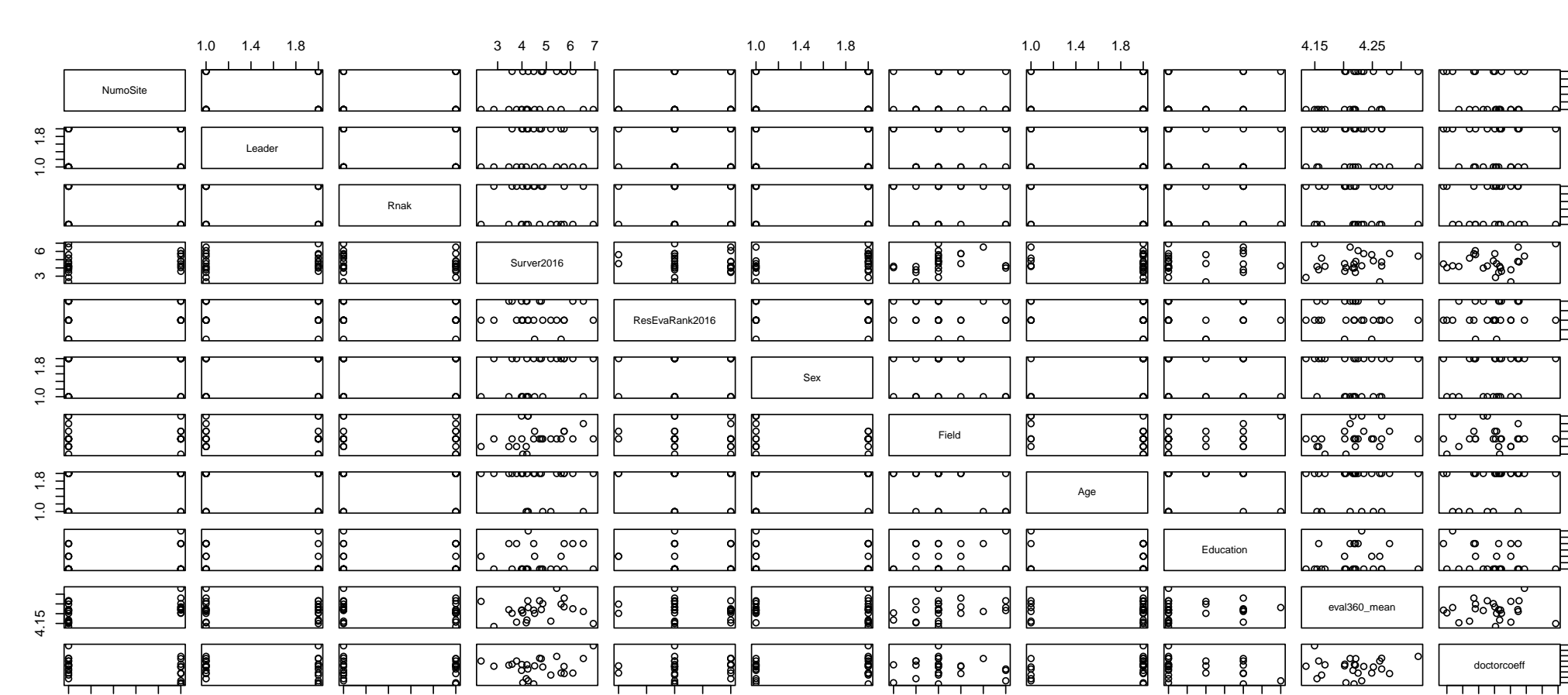


Figure 5 The Plot of Physician Quality Indicators with respect to Physician Characteristics

Conclusion

By fitting a two-level hierarchical model, which brings all the given data together, we conclude first that physician play a role in patient outcome, second that the most significant factors for the physician evaluation in critical care are the following:

- Number of sites they work at
- Average overall score from survey in 2016
- Their rank
- The field in which they received training
- Their education
- Their age
- Mean of all 360 evaluation survey answer scores

These reliable predictors of physician performance would be beneficial to inform educational strategies, performance evaluations and hiring approaches in the ICU.

Extension of this research could show predictive power of this metric. We recognize that our model does not take into account hospital demographics and team dynamics, among other important factors.

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References

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