# Risk Adjustment at the IQTIG

## Status quo and open problems

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# Outline

1 Context

2 Current projects

- Validity of risk adjustment models
- Provider random effects
- Using simulations to understand modeling choices
- Time evolution of risk adjustment models
- Modeling of continuous variables

3 Conclusions

# Context

# Quality indicators

- Currently, the IQTIG manages ~220 quality indicators in various clinical areas.
- ~60 of these quality indicators are risk adjusted.
- **Purpose:** External quality assurance. Depending on the clinical area, providers with poor indicator results are contacted by:
  - either the IQTIG directly,
  - or agencies at the federal state level.
- Most risk adjustment models rely on clinical (and administrative) data provided by hospitals.
- The number of models that include administrative data from statutory health insurers is increasing.

# Types of risk adjusted indicators

- The vast majority of risk adjusted indicators are of SMR type:

$$\frac{O}{E} = \frac{\text{observed number of adverse outcomes}}{\text{expected number of adverse outcomes}}.$$

  (indirect standardization, $E$ from logistic regression)
- A few indicators are indices that combine observed/expected numbers of $k$ different outcomes:

$$\frac{O^{(1)}+O^{(2)}+\cdots+O^{(k)}}{E^{(1)}+E^{(2)}+\cdots+E^{(k)}}.$$

- Other uses of risk adjustment include:
  - Define population, e.g. mortality among low risk patients.
  - Monitoring of providers' average risk $E/n$.
- In the future: Continuous outcomes, e.g. radiation dose during pacemaker insertion.

# Current projects

# Evaluating risk adjustment model

- Assessing validity of a risk adjustment model is not a purely statistical task, but includes such dimensions as[1]:
  - content validity: Are all relevant risk factors included?
  - prediction validity: Can the model predict the outcome?
  - face validity: Is the model accepted by stake holders?
    ⟶ Transparency about models and methods

## Our Goals:

- Summarize different validity dimensions of our models in a structured way.
- Make modeling choices well-founded and increase consistency between models.

[1] Risk Adjustment for Measuring Health Care Outcomes, Fourth Edition (Aupha/Hap Book), 2012, ed. L. Iezzoni.

# Prediction validity of a risk adjustment model

- Usually, quantities from regression analysis (e.g. AUC, (pseudo-)$R^2$) are reported, but they are not direct measures of statistical validity of risk adjustment models.
- Risk adjustment models are not used to predict actual outcomes, but *counterfactual outcomes*:
  - What would have been the outcome if the treatment had been provided by an average provider?
- Risk adjustment models *define* a benchmark $E$ with which the providers' outcomes $O$ are compared.
  - How can we ensure that this benchmark is adequate and fair?

# Introducing provider random effects

- In 2020, we started to include provider random effects when estimating some of our models.
- Provider effects are used to estimate $E$ (not to shrink SMRs):

**1** Fit a (logistic) model that includes provider effects:

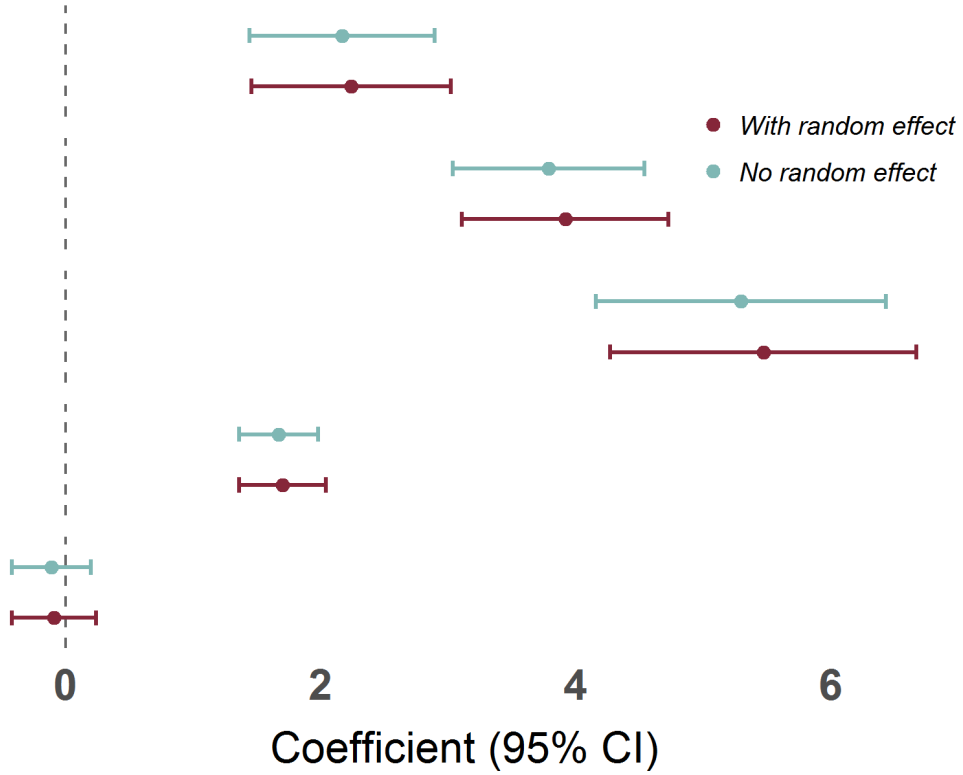
$$\pi_{ij} = \text{logit}^{-1}(\beta_0 + \boldsymbol{\beta}^T \boldsymbol{x}_{ij} + \theta_i)$$

- $\pi_{ij}$ - risk for patient $j$ treated by provider $i$
- $\boldsymbol{x}_{ij}$ - risk factors
- $\boldsymbol{\beta}$ - model coefficients
- $\beta_0$ - intercept
- $\theta_i$ - provider effect (as random effects $\sim N(0, \tau^2)$)

**2** Compute "benchmark" risk per patient with $\theta_i \to 0$, and sum:

$$E_i = \sum_j e_{ij}, \qquad \text{where} \quad e_{ij} = \text{logit}^{-1}(\hat{\beta}_0 + \hat{\boldsymbol{\beta}}^T \boldsymbol{x}_{ij})$$

# Example: Mortality after pace maker revision




- **Observation**: When using random provider effects, coefficients $\hat{\beta}$ tend to increase by a small amount.

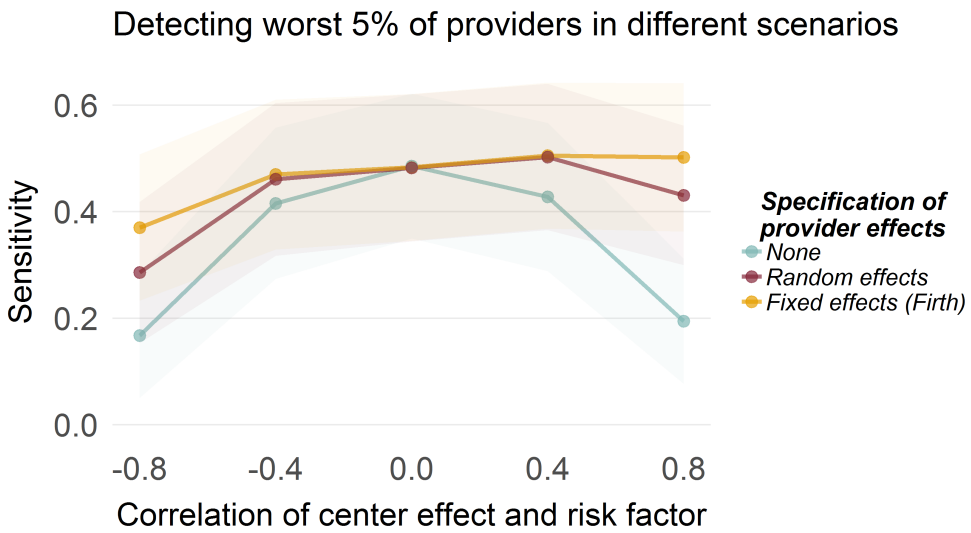
# Evaluating the use of random effects

- There are clear theoretical reasons for using provider effects; but:

**Question:**

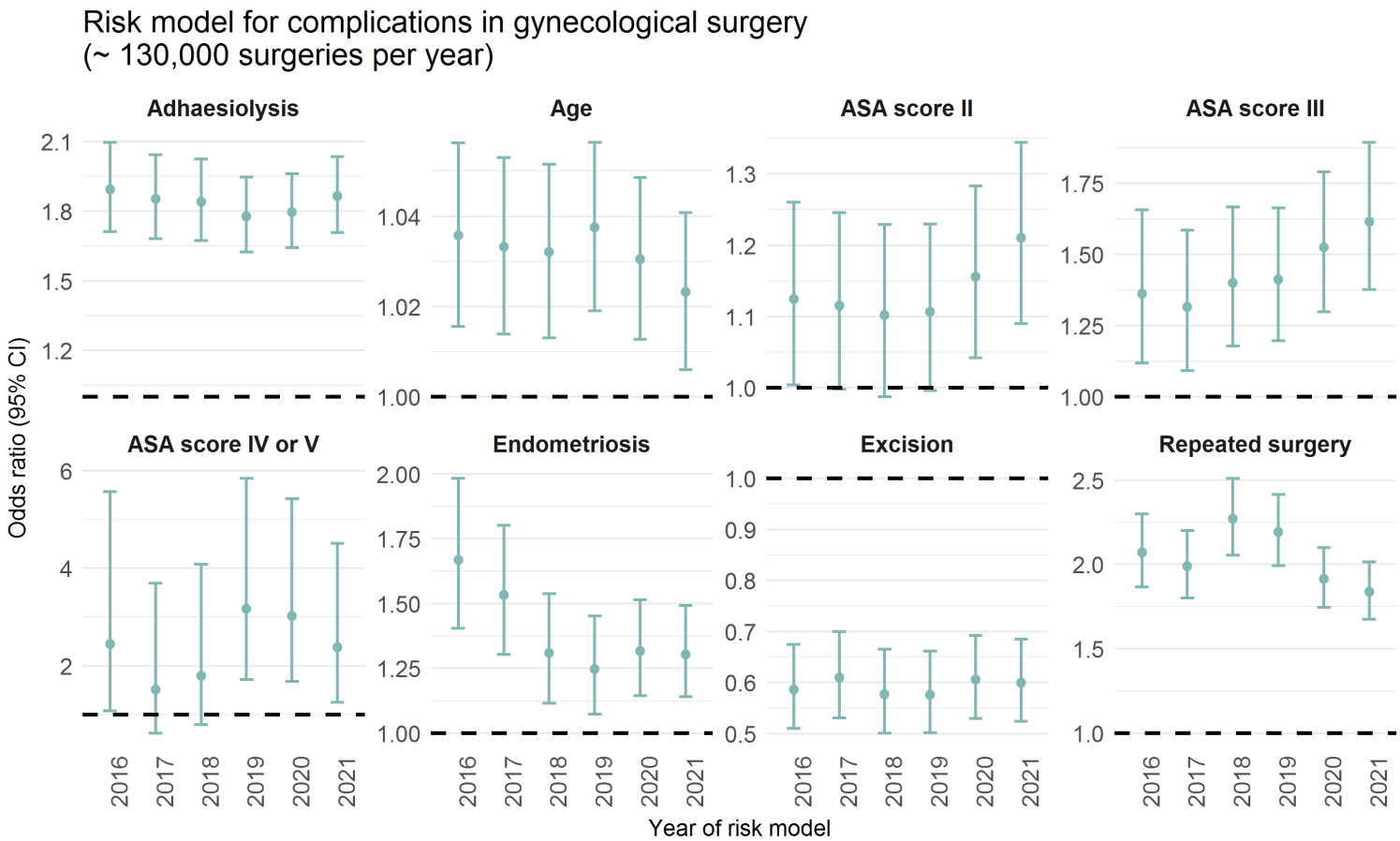
How to confirm that models improve when including provider effects?

- AUC and pseudo-$R^2$ do not work.
- Simulations help to understand the implications.



# Time evolution of risk adjustment models

- Most risk adjustment models are updated once a year.
- Some models need a more thorough overhaul, sometimes a coefficient update suffices.



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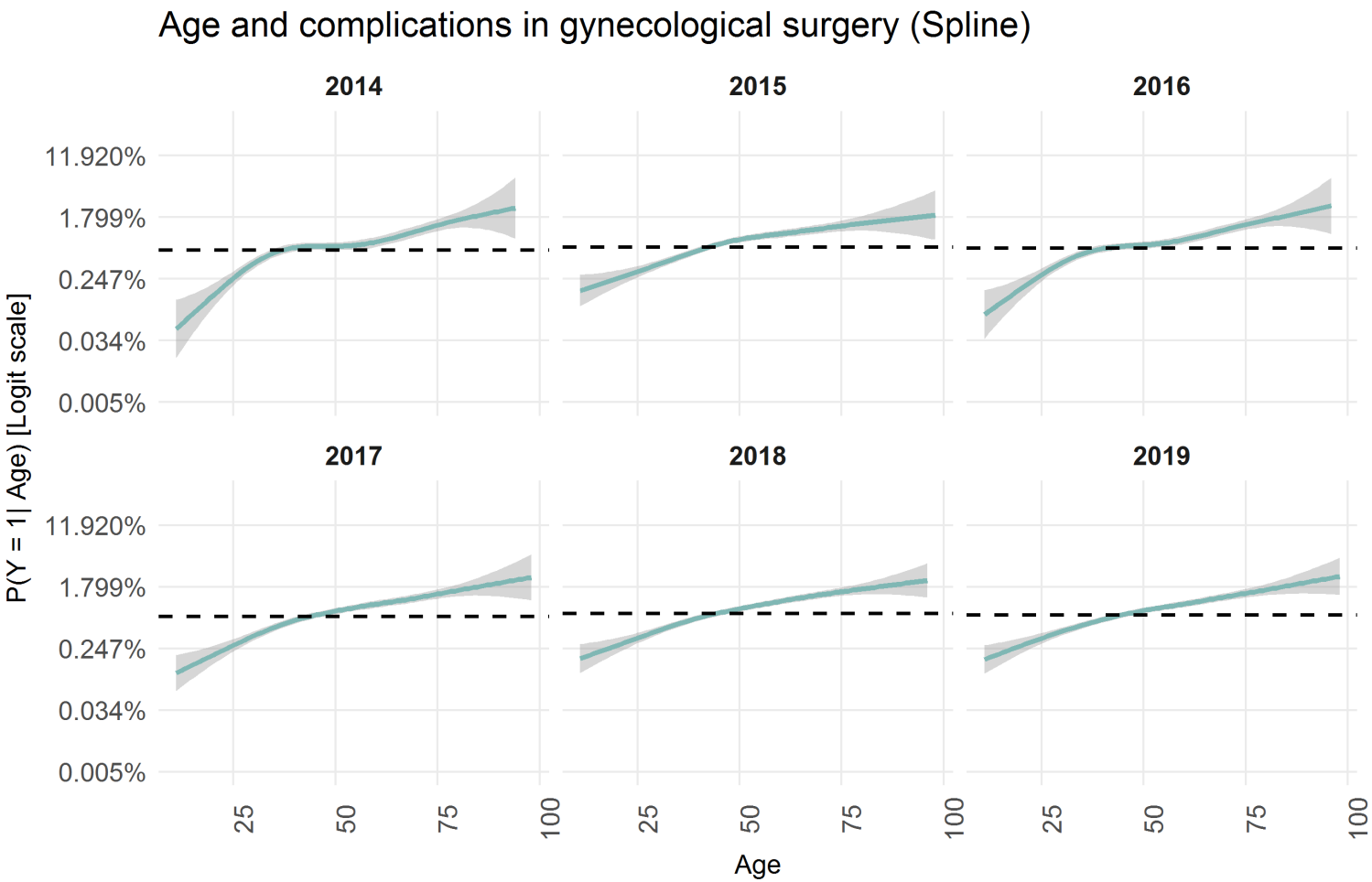
**Question:**

- How can we incorporate prior information of past models?

- **Variable selection:**
  - Use last year's selection as a starting point for model selection.
- **Coefficients:**
  - Shrink towards last year's coefficients?
  - Can we use ideas from meta analyses?

# Modeling of continuous variables




- In 2017, we began moving from quintiles to continuous functions.

# Conclusions

# Conclusions

- The IQTIG develops and manages $\sim 60$ risk adjustment models.
- In a regulatory setting, we need to strike a balance:
  - To ensure validity, our methods need to be up to date.
  - To ensure face validity, we need to be transparent and comprehensible.
- Some topics that we are currently working on:
  - How to assess and present validity of our models?
  - Building a simulation framework
  - Introducing provider effects
  - Taking time into account: How to best update our models?
  - Risk adjustment for continuous outcomes and indices
  - Smooth modeling of continuous risk factors