Discussion (10/15/2013)
Statistical Methods in Geographic Variations by Thérèse A. Stukel

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Important Events in 2013

• Jack E. Wennberg Conference
• International Year of Statistics ("Statistics2013")
• 250 years since Bayes Theorem first presented publically
• 300 years since Jacob Bernoulli’s Ars Conjectandi, seminal work on probability (including law of large numbers)
Why Model Provider Variations?

• Enable equitable comparisons between health units (hospitals, health plans, regions ...)  
  – Account for differences in patient populations
• Identify sources/causes of variations
• Understand patterns of variation  
  – Report rates with maximum precision
Adjusting for Patient Case-mix

1. Model outcomes, then make predictions for target population

2. Model selection, then weight observations to equate to standard population

3. Combine the above two approaches

• First approach is most common; latter two seen more in survey analysis and causal inference
Controversies

• Type of Adjustment
  – Indirect standardization
  – Fixed effects model
  – Random effects models
• Inclusion of unit-level predictors (e.g., hospital volume) in model
• Borrowing strength from prior years
• Use of Bayesian modeling
An Experimental-design

- Randomly assign patients to hospitals (H)
- Measure outcome (Y) for each patient in each hospital
- Gain precision by adjusting for patient characteristics (X)
- Specification of H as random or fixed depends on target population of interest
  - These hospitals or all hospitals
  - Systematic and stochastic components of variation (McPherson, Wennberg et al 1982)
Observational Data: Patients not randomly assigned to hospitals

• Model as for randomized design

\[ Y_{jk} = \beta_0 + \theta_j + \beta_1 X_{jk} + e_{jk} \]

• \( \theta_j \) is effect of jth hospital

• Assume \( X_{jk} \) independent of \( e_{jk} \) (and for FE)

• Assume \( \theta_j \) independent of \( e_{jk} \)

• Assume \( X_{jk} \) independent of \( \theta_j \) ?

• Identification: \( \theta_j \) has normal distn
Subtle Generalization of RE Model

• Repeated measures allow distinction between individual and group level effects
\[ Y_{jk} = \beta_0 + \beta_b \bar{X}_j + \theta_j + \beta_w (X_{jk} - \bar{X}_j) + e_{jk} \]

• Now \( \theta_j \) independent of \( \bar{X}_{jk} = X_{jk} - \bar{X}_j \)

• Perceived weakness of random effect modeling (Kalbfleisch and Wolfe, 2013) lessened/removed?

• Clarifies distinction between RE and FE!!!

• Ideally end up with \( \text{var}(\theta_j) = 0 \)
Shrinkage is natural?

• If the model is correct you must win!
• The problem is really that the mean is not an adequate summary. Why not report:
  – 5% and 95% quintiles of posterior distribution too
  – Summarizing information multiple ways is not multiple testing!
• If concerned about outliers use a model that allows for outliers (Jones and Spiegelhalter, 2011; Ohlssen et al 2006; West 1986)
Reduce shrinkage by allowing small hospitals to borrow from prior years

• Bidirectional smoothing (Jones and Spiegelhalter 2011)
• Use hierarchical model with time series component to yield better predictions of health care performance indicators
Summary

• Modeling and reporting are distinct tasks
  • Mixing them up leads to confusion
  • Output from fitted model can be translated in multiple ways to effectively communicate to stakeholders
• Only one model!

• Hierarchical models are flexible
  – Embrace and allow for heterogeneity!
Another Generalization

- As in a randomized block design, allow interactions with block
- Random-intercept, random-slope model:
  \[ Y_{jk} = \beta_0 + \theta_{0j} + (\beta_1 + \theta_{1j})x_{jk} + e_{jk} \]
- Model identification: \( \theta_j = (\theta_{j0}, \theta_{j1}) \) has bivariate normal distn
Spatial statistics methods

• Geographic variations literature seldom uses models for spatial statistics
• If unit-level correlations dissipate smoothly with distance account, model spatial correlation and obtain more precise results
• Dilemma: Do you want to explain away spatial correlations?