Supplemental Digital Content 3

Mixed Effects Logistic Regression Models

Multilevel analysis is a general method of analyzing data with a hierarchical or clustered structure. Multilevel models allow clinical decisions — such as prescribing decisions — to depend on patient, physician, and clinic fixed and random effects in complex ways, and have previously been applied for the profiling of health care providers.[1,2] Our data set consists of two distinct levels: patient- and hospital-level information. We specified a mixed effects logistic regression model that allowed the patient level outcome (being treated with second-line uterotonics) to depend on patient- and hospital fixed effects (embedded in the propensity score) and hospital random effects:

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_0 + \beta_1 * PS\_centered_{ij} + b_j$$

p_{ij} : i^{th} patient of the j^{th} hospital's probability of receiving second-line uterotonics

β_1 : coefficient associated with the patient-level propensity score, centered on the mean

β_0 : marginal (averaged across hospitals) probability of being treated with uterotonics for a patient with the mean propensity score (PS_centered=0)

b_j : hospital-level random intercept

b_j $\sim N(0,\sigma_b^2)$, where σ_b^2 is the between-hospital variance and represents the hospital-specific deviation from β_0

The parameter of interest for the description of the variation in prescribing tendency is σ_b^2. The hospital-specific probability of prescribing a second-line uterotonic for the 'average' or 'typical' patient in the study is given by:

$$\frac{\exp(\beta_0 + b_j)}{1 + \exp(\beta_0 + b_j)}$$

The interval that contains the prescribing probability for the 95% hospitals in the center of the range is given by:[3]

$$\left(\frac{\exp(\beta_0 - 1.96\sigma_b)}{1 + \exp(\beta_0 - 1.96\sigma_b)}; \frac{\exp(\beta_0 + 1.96\sigma_b)}{1 + \exp(\beta_0 + 1.96\sigma_b)} \right)$$

References:

1. Normand S, Glickman M, Gatsonis C. Statistical methods for profiling providers: issues and applications. Journal of the American Statistical Association 1997;92(803-814).
2. Daniels MJ, Gatsonis C. Hierarchical polytomous regression models with applications to health services research. Statistics in Medicine 1997;16(20):2311-2325.
3. Fitzmaurice G, Laird N, Ware J. Applied Longitudinal Analysis. Hoboken, New Jersey: John Wiley & Sons, Inc., 2004.