Trends in Reported Foodborne Illness in the United States: 1996-2013

Mark Powell
U.S. Department of Agriculture, Office of Risk Assessment and Cost-Benefit Analysis
Washington, DC

International Association for Food Protection
28 July, 2015
Portland, OR
INTRODUCTION

• Current statistical methods for analyzing FoodNet data make pair-wise comparisons between most recent surveillance year and one or more baseline periods.
• Advantage: avoids specifying model form for trend
• Disadvantage: can’t distinguish trends from year to year variability
• Objective: Analyze trends in reported U.S. foodborne illness with/without specifying model form for trend
DATA

- FoodNet (Foodborne Diseases Active Surveillance Network) data: 1996-2013
  - Reported illness counts by site (State_EntYr) and year
  - Population size by site and year (increased over time)
  - FoodNet composition stable since 2004

- Campylobacter
- Listeria
- Salmonella
- Shigella
- STEC O157
- Vibrio
- Yersinia
METHODS

• Poisson Log-Linear Model with Site (1996-2013)
  – \( \log(\text{count}_{ij}) \ (y_{ij}) = \log(\text{population}_{ij}) + b_0 + b_1 (\text{Year}_i) + b_j (\text{Site}_j) + \varepsilon_{ij} \)
  – \( E[y_i] = \mu_i \) (point on predictive curve)
  – Poisson (count) model is heteroscedastic
    • Generalized Poisson dispersion: \( \text{Var}[y_i] = \phi \mu_i \)
    • Negative Binomial dispersion: \( \text{Var}[y_i] = \mu_i + \delta \mu_i^2 \)
  – Differs from CDC method in that time is treated as a continuous covariate, considers generalized Poisson as well as negative binomial dispersion
• A conventional approach, but assumes log-linear trend
METHODS

• Penalized B-spline Regression
  – Semi-parametric method – no assumed trend model form
  – B-spline basis functions provide local control, local fit is insensitive to points far removed
  – Penalized form of B-spline regression is insensitive to number, placement of join-points (“knots”)
METHODS

• X: cubic B-spline basis with 2 internal knots
  – 6 basis functions (unconstrained)
• S: 2\textsuperscript{nd} order difference matrix
  – penalize differences among neighboring coefficients ($\beta$)
• All Sites (1996-2013)
  – Composition of FoodNet sites stable since 2004
• Original 5 Sites (1996-2013)
  – Attempt to control for changes in FoodNet composition over time
Preliminary Results: Poisson Log Linear Model

• Significant Negative Trend Term
  – *Campylobacter, Listeria, Shigella, STEC O157*, and *Yersinia*

• Significant Positive Trend Term
  – *Vibrio*

• Significant Site-Level Effects
  – All pathogens
Preliminary Results: Poisson Log Linear Model

- *Salmonella*
  - Significant Positive Trend Term for Generalized Poisson
  - No Significant Trend Term for Negative Binomial
- Generalized Poisson better fit than Negative Binomial
  - All pathogens (incl. *Salmonella*)
- Log linear model not a good overall fit
Preliminary Results: Penalized B-Spline Regression

- *Campylobacter, Listeria, STEC O157, Yersinia*
- Early declines followed by a period of no significant trend
- Results consistent for All Sites, Original Sites, Generalized Poisson, Negative Binomial
Campylobacter

1996-2013, original sites, generalized Poisson
Listeria

1996-2013, original sites, generalized Poisson
STEC O157

1996-2013, original sites, generalized Poisson
Yersinia

1996-2013, original states, generalized Poisson
Preliminary Results: Penalized B-Spline Regression

- *Shigella* and *Vibrio*
- Continuous trends without an apparent plateau
- *Shigella* decreasing
- *Vibrio* increasing
- Results consistent for All Sites, Original Sites, Generalized Poisson, Negative Binomial
Shigella

1996-2013, original sites, generalized Poisson
Vibrio

1996-2013, original sites, generalized Poisson
Preliminary Results
Penalized B-Spline Regression

• *Salmonella*

• Inconclusive whether there is no trend or an increasing trend
  – Significant Trend in All Sites, 1996-2013
    • Inf. Smooth → Log-linear model (p<0.01)
  – No Trend in Original 5 Sites, 1996-2013
Salmonella

All Sites, 1996-2013

Original Sites, 1996-2013
SUMMARY

• Early decline followed by year-to-year variability about lower level
  – *Campylobacter*, *Listeria*, STEC O157, *Yersinia*
• Continuous decline
  – *Shigella*
• Continuous increase
  – *Vibrio*
• Inconclusive whether increase or no trend
  – *Salmonella*
Limitations

• Results are preliminary
• Reported illness is a proxy, not true incidence
• Not all FoodNet reported illness is foodborne
• Assumes data missing at random
• Descriptive model, not infer causes
• Uncertainty about generalizing from FoodNet population to national level not quantified
Acknowledgements

• Data Provided by Foodborne Diseases Active Surveillance Network, CDC
  – Olga Henao, Elaine Scallan et al.
  – Stacy Crim, CDC
  – Mike Hoekstra, CDC
  – Mike Williams, FSIS
Disclaimers

• Results are preliminary and have not been subject to a formal peer review process.

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Thank you