

Robust Outbreak Surveillance

Marianne Friséen
 Statistical Research Unit
 University of Gothenburg
 Sweden

Marianne Friséen S-gem 2009

1

Aims of outbreak surveillance

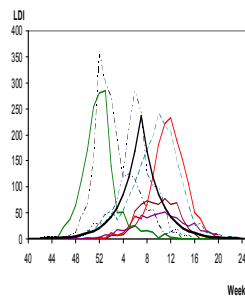
- Detect an unusually high incidence
- **Detect that an increase has started**
- Detect that the decline has started

Marianne Friséen S-gem 2009

2

Examples of outbreak definitions

- Identified common source of infection
- **Higher incidence than usual**
- **Higher than usual for the season**
- **An increase of the incidence has started**



Marianne Friséen S-gem 2009

3

Methods for unknown parameters

- Much theory for unknown change sizes – less for unknown baseline
- Estimation from historical data
- Priors
 - Mixture Likelihood Ratio
- **Pivot statistics**
- **ML estimation**
 - **Generalized Likelihood Ratio (for both baseline and change)**

Marianne Friséen S-gem 2009

4

Robust method for detection of rise or decline

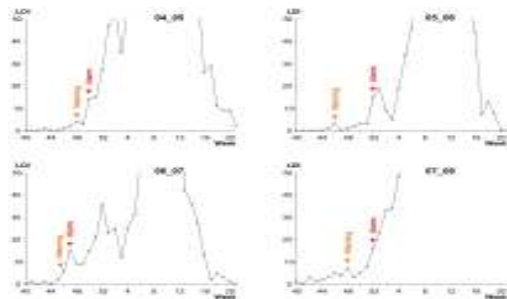
- Specify states C (nonepidemic) and D (epidemic) in terms of monotonicity
- Maximize the likelihood under the restrictions

Signal when the ratio between the maximal likelihood exceeds a limit

$$\left\{ x_s : \frac{\max f(x_s|C)}{\max f(x_s|D)} \geq k' \right\}$$

Marianne Friséen S-gem 2009

5



Marianne Friséen S-gem 2009

6

Subjective judgment vs automatic

- Less efficient
- Large variation between judges
- + expert knowledge

- **Combination!**

Marianne Frisé S-gem 2009

7

Parametric vs non-parametric method Simulation study

- Exactly known baseline
 - The parametric method is better than the nonparametric
- Estimation - with the efficiency available for Swedish influenza
 - When the baseline is over-estimated the delay is about the same as for the nonparametric method
 - When the baseline is under-estimated, the predicted value is very low

Marianne Frisé S-gem 2009

8

Tularemia 1998-2003 Sweden

Rolfhamre P, Ekdahl K.

An evaluation and comparison of three commonly used statistical models for automatic detection of outbreaks in epidemiological data of communicable diseases. *Epidemiology and Infection* 2006; 134:863-871. and **OutbreakP**

Method	Sensitivity %	PPV %	Swiftness
OutbreakP	100	100	4
SPOTv2	100	100	3
EW	80	100	2
CuSum 2	43	100	2
CuSum 1	43	60	1

Marianne Frisé S-gem 2009

9

Possible reason for good results I

- The other methods compare observations with an uncertain baseline
- The Outbreak method evaluates evidence of increase

Marianne Frisé S-gem 2009

10

Possible reason for good results II

- Some of the other methods use only the last observation
- The Outbreak method accumulates information in an optimal way

Marianne Frisé S-gem 2009

11

Computer programs

- Download and instructions
 - www.statistics.gu.se/surveillance
 - isds.wikispaces.com/Resources

Marianne Frisé S-gem 2009

12

Pre-specifications?

- No need for baseline estimation
- **The alarm limit** is determined by the same specifications as for other methods
 - Trial and error
 - False alarm property requires specifications
 - **Predicted value** requires specifications

Marianne Frisén S-gem 2009

13

Predicted value

- Probability of an outbreak
 - given that there is an alarm
 - For warning signals about 0.95
 - For alarm signals about 0.99
- Based on knowledge on influenza

Marianne Frisén S-gem 2009

14

Next step

- Combine information
- Multivariate surveillance
- Spatial information

Marianne Frisén S-gem 2009

15

Sufficient reduction at a time lag

- *For processes which each belong to the one parameter exponential family there exist a sufficient reduction to a univariate statistic*
 - Järpe, E. (2000). *On univariate and spatial surveillance. Ph.D Thesis. Department of Statistics, Göteborg University, Göteborg.*
 - Frisén, M., Andersson, E. & Schiöler, L. (2009) Sufficient reduction in multivariate surveillance. Submitted.

Marianne Frisén S-gem 2009

16

Computer-generated outbreak signals

- Methods can be further developed
 - To efficiently use the available data
 - To be better adapted to the needs
- Routine use necessary
 - To detect new threats
 - To give information for planning
- Should be a complement

Marianne Frisén S-gem 2009

17

<http://www.statistics.gu.se/surveillance>

Marianne.Frisen@statistics.gu.se

Marianne Frisén S-gem 2009

18