Simulation of Correlated Outbreak Signals for Early Aberration Reporting

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OBJECTIVE

We present a pilot study of simulation of correlated outbreak signals for early aberration reporting and evaluating detection methods.

BACKGROUND

The Early Aberration Reporting System (EARS) was developed at the Centers for Disease Control and Prevention to help assist local and state health officials to focus limited resources on appropriate activities of public health surveillance [1]. Outbreaks of infectious diseases are indicated in multiple spatial and temporal data sources, such as emergency department visits, drug store sales, and ambulatory clinic visits. Based on this premise, we provided correlated data sets and investigated disease clusters.

METHODS

We simulated respiratory syndrome outbreaks in four county (A, B, C and D) emergency departments (ED). The center of the simulated outbreak was in county A and it spread to neighboring counties. A few days later, B (8 miles away), C (27 miles away) and D (30 miles away) counties reported outbreaks. First, we generated different background data for each ED associated with their trend, seasonality, mean, standard deviation during the year of 1999. Secondly, we generated signals with a lognormal distribution for seven days or less. Then we injected different amount of signals into backgrounds of A, B, C and D with consideration of geographic distance. Finally we detected those signals using the C2 method [1] with sliding 7 and 14-day baselines.

RESULTS

Figure 1 shows the geographical spread of the outbreak across counties by days. Figure 2 shows simulated respiratory background and injected signals for county A. Signal-to-noise ratio (SNR) is defined as the total number of signal counts during days of the signals injected divided by the total number of background counts during the signal periods. Our result shows that SNR were 6.80, 6.61, 4.65 and 2.03 in summer; 0.73, 1.05, 0.61 and 0.42 in fall for A, B, C and D Counties, respectively. The percentage of alerting days versus total injected days were 60%, 60%, 60% and 40 % in summer, and 20%, 40%, 40% and 20% in fall for A, B, C and D. Applying 1% alert rate, the sensitivities were 0.40, 0.44, 0.50 and 0.50 for 7-day baseline, and 0.44, 0.60, 0.35 and 0.60 for 14-day baseline using C2 methods.

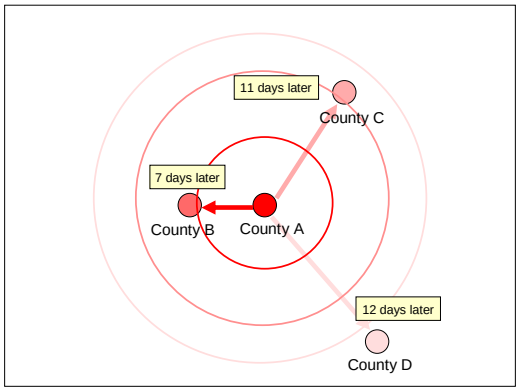

Figure 1 – Geographic map of respiratory outbreak cluster and date of injected signals at emergency departments for A, B, D and D counties.

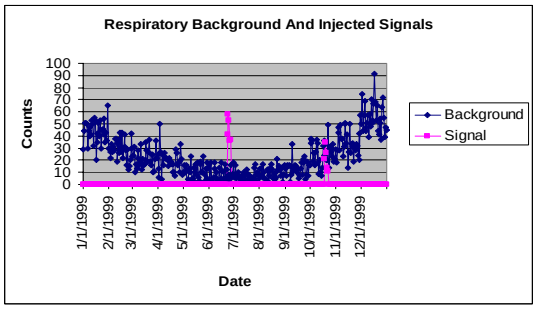

Figure 2 – Simulated respiratory background and injected signals for emergency department of A county.

CONCLUSIONS

This pilot study investigated the effects of multiple spatiotemporal factors on early aberration alerting. The individual analytical results do not vary from what was expected. The effects of trend and seasonality, and SNR were seen in the various data sets and behaved as anticipated. Data sets such as these correlated data sets can be used to test multivariate methods and how they behave. These data sets can be used to look at the correlation between other various data sources such as clinic, drug store and lab data.

REFERENCES

[1] Hutwagner, L., etc (2003). The Bioterrorism Preparedness and Response Early Aberration Reporting System (EARS). *Journal of Urban Health vol. 80:i89-i96.*