Multi-method comparison of detecting common events of public health interest: a multi-site, multi-stream simulation study

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OBJECTIVE

We used simulation methods to assess the performance of two distinct anomaly-detection approaches, each under a variety of parameter settings, with respect to their ability to detect outbreaks of commonly occurring events of public health importance.

BACKGROUND

Existing statistical methods can perform well in detecting simulated bioterrorism events [1]. However, these methods have not been well-evaluated for detection of the type of respiratory and gastrointestinal events of greatest interest for routine public health practice. To assess whether a syndromic surveillance system can detect these outbreaks, we constructed simulated outbreaks based on public health interest and experience. We then inserted these outbreaks into real data. We assessed whether the simulated outbreaks could be detected using a battery of detection methods, including model-adjusted scan statistics [2] and space-time permutation scan statistics [3].

METHODS

Six simulated lower gastrointestinal or influenza outbreaks were created, based on public health experience (Table 1). These were added to ambulatory care data collected in Massachusetts by the National Bioterrorism Syndromic Surveillance Demonstration Program [4] from June 2005 through May 2006. The program covers approximately 10% of the population in the simulation region. In table 1, overall cases added across the days reflects 10% of persons supposed affected in the population. Outbreaks were added to a random zip code and nearby zip codes on each day of the year.

Table 1: Simulated outbreaks

Sim.	Scenario	# Days	Overall # Cases Added	# Zip codes
LGI1	*Salmonella*, party	3	10	3
LGI2	*e. Coli*, restaurant	1*	10	10
LGI3	*Giardia*, public pool	14	10	3
LGI4	*Salmonella*, fair	14	50	10
ILI5	Influenza, school	14	20	3
ILI6	Pandemic influenza	14	100	20

* As part of a longer outbreak where our surveillance must detect on the first day to be useful.

Statistical methods were a space-time permutation [3] and model-adjusted [2]scans. Models examined were "window-gap" models: an 1) intercept, or 2) intercept + slope terms estimated within the window used to generate the count expected after the end of the gap. A 90-14 window-gap model uses data from the first 90 days to estimate the count on the 105th day. Each model was used with windows of 30, 60, and 90 days and gaps of 7 and 14 days. Permutation scans used 42, 90, 180, or 365 days of historical data. Both permutation and model-adjusted parametric scan statistics used 10% or 50% of the region for maximum circle areas and 7 or 14 day maximum cluster lengths. Evaluation is performed through a weighted ROC technique that incorporates timeliness as well as sensitivity and specificity. [1]

RESULTS

Results shown in table 2 reflect dominance of the permutation scan with parameters depending on simulation. The permutation method with 365 days history, and 7 days and 50% maximum signal extent was nearly as good as the best method in all cases.

Table 2: Results

Sim.	Best method	WROC (max = 1) for best method	WROC for STP-365-7-50
LGI1	STP-180-7-50	.435	.426
LGI2	STP-180-7-50	.448	.446
LGI3	STP-180-7-10	.588	.582
LGI4	STP-365-7-50	.748	.748
ILI5	STP-365-7-50	.689	.689
ILI6	STP-365-7-10	.782	.781

CONCLUSIONS

In these examples, the space-time permutation scan was uniformly better than the model-adjusted parametric scan. We can recommend 7 day and 50% area maximum cluster extent for detecting clusters like the ones simulated, and at least 365 days history.

REFERENCES

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