# DEVELOPMENT AND EVALUATION OF OUTBREAK DETECTION ALGORITHMS FOR COMMUNICABLE DISEASES

## Executive Summary

The literature describes several different statistical methods to aid in outbreak detection from routine surveillance data. Based on the results of our preliminary review of existing methods, we developed and evaluated four outbreak detection methods that could be useful within Los Angeles County (LAC). All four methods have in common that either the current week's case count or that of the current last four weeks are compared to a reference. From this reference a threshold is calculated. If this threshold is exceeded, an alarm is triggered.

**Table 1. Comparison of Four Outbreak Detection Methods**

| Name of Method | Weeks of interest | Reference period | Alarm Rule |
|---|---|---|---|
| Column 1<br>Current-Year | Column 2<br>current week | Column 3<br>previous 6 weeks | Column 4<br>If no. of cases in col. 2 > [average of no. of cases in col. 3 + 2sd*] |
| Current/ Previous-Year | current week | five 6-week blocks (two from current year; three from previous year) | If no. of cases in col. 2 > [average of medians of five 6-week blocks in col. 3 +2sd*] |
| MMWR Five-Year | current 4-week period | 15 previous 4-week blocks (three each from previous 5 years) | If [col. 2 ⁄ mean of col. 3] > [1 + 2 (sd* of col. 3 ⁄ mean of col.3)] |
| CuSums | current week | five 6-week blocks (two from current year; three from previous year) | "Delta" = col. 2 - average of medians of col. 3<br>Cusum = Cumulative sum of deltas<br>Alarm: If sum of four deltas > average of medians of col. 3 |

***standard deviation**

To test these methods, we chose to use the campylobacteriosis database, which contains data with consistent quality back to 1983. With approximately 1200 cases annually (ranging from 825-1725 cases), campylobacteriosis is reported frequently enough to apply these statistical tests for identification of possible outbreak situations. We created a spreadsheet of campylobacter case reports from 1983 to 1998 by week of occurrence. Using these data, we created individual spreadsheets for each outbreak detection methods. Since the MMWR Five-Year Method requires five years of historical data 1988 was the first

year that all four methods could be implemented. We defined an “alarm week” as a week in which at least one method triggered an alarm. From 1988 to 1998, 161 weeks triggered at least one alarm for an average of 14.6 alarm weeks per year. Among the weeks with any alarms during this time period, 90 (56%) had one alarm, 51 (32%) had two alarms, 17 (11%) had three alarms, and 3 (2%) had four alarms.

Not every statistical alarm indicates an outbreak, so we aimed to evaluate periods that were either “more likely” to represent outbreaks or which were known periods of historical outbreaks. We therefore selected first, based on arbitrary rules based on frequency of alarms, 15 “alarm periods” of 1-4 weeks’ duration (with possible outbreak “character”) in addition to ten “known outbreak periods” of campylobacteriosis between 1983 and 1998.

We explored the hypothesis that cases from alarm periods/known outbreak periods differ from generally occurring campylobacter cases. We compared cases from alarm periods/known outbreak periods with cases reported in “comparison periods” by race, sex, age, and place of residence. The comparison period was determined similarly to the reference period in the Current/Previous-Year Method. Since we compared four variables, we calculated a total of 60 (15x4) p-values for the alarm periods and 40 (10x4) p-values for the known outbreak periods. We defined a statistical test as significant if it yielded a p-value of $\leq 0.05$. Among the alarm periods, 11 (18.3%) of the 60 p-values were $\leq 0.05$. Among the 10 known outbreak periods, 8 (20%) of the 40 p-values were $\leq 0.05$.

Because it was not possible to verify differences observed between alarm periods/known outbreak periods and comparison periods through in-depth investigations, we attempted to at least evaluate the frequency of statistically significant results. Again, we assumed that weeks without alarms are representative of the “general population” of cases of campylobacter. We therefore “evaluated” those non-alarm weeks just as if they were alarm-weeks and defined comparison weeks to those weeks without alarms exactly as we did for the weeks with alarms/known outbreaks. One would then expect that the statistical analyses of campylobacter cases from weeks with no alarms versus campylobacter cases from comparison weeks would not yield as many results with p-values of $\leq 0.05$ as were observed in the analyses of the alarm periods/known outbreak periods. We randomly selected one period per year from 1988 – 1998 (n=11) out of the pool of weeks with zero alarms. In the analysis of the 11 randomly selected non-alarm periods, we performed 44 (11 x 4) comparisons and only two (4.5%) of these resulted in p-values $\leq 0.05$.

Finally, we calculated a Chi-square statistic comparing the frequency of significant differences (n = 11 + 8 = 19) for age, sex, race, or place of residence found in the analysis of the alarm periods/known outbreak periods to that in the randomly selected non-alarm periods (n=2). An analyzed comparison in the alarm periods/known outbreak periods was

4.9 times (95% confidence interval = 1.03 – 32.2; p=0.02) more likely to result in a significant p-value than an analyzed comparison in the random non-alarm periods.

Certain alarm weeks/known outbreaks could contain subpopulations of cases of campylobacteriosis whose differences might be picked up by the simple analysis of demographic variables. Our findings suggest that there may in fact be hidden outbreaks of campylobacteriosis that may be detectable with the use of outbreak detection methods such as the ones described here.

In summary, we showed that it is relatively simple to implement up to four different outbreak detection methods. Health departments may want to use them either individually or in combination to identify frequency patterns that warrant further investigation. In the future, we recommend implementing these methods prospectively in order to determine the validity and usefulness of the methods.