

# Beyond Detection: Attack Characterization with Syndromic and Clinical Data

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## OBJECTIVE

Upon detection of an inhalational anthrax attack, a critical priority for the public health response would be to characterize the size and extent of the outbreak. Our objective is to assess the potential role of syndromic surveillance in estimating the outbreak size.

## BACKGROUND

Most research in syndromic surveillance has emphasized early detection, but clinical diagnosis of the index case will tend to occur before detection by syndromic surveillance for certain types of outbreaks [1]. Syndromic surveillance may, however, still play an important role in rapidly characterizing the outbreak size because there will be additional non-diagnosed symptomatic cases in the medical system when the index case is identified. Other authors have shown that the temporal pattern of symptomatic cases could be used to project the total outbreak size, but their approach requires *a priori* knowledge of the incubation curve for the specific anthrax strain and exposure level [2]. In this paper, we focus on estimating the number of non-diagnosed symptomatic cases at the time of detection without making assumptions about the exposure level or disease course.

## METHODS

We developed an algorithm for estimating the number of syndromic cases attributable to an anthrax outbreak at the time of the initial clinical diagnosis. To estimate the number of cases  $C$  at time  $t$ , we define a window of  $w$  days duration to ‘look back’ for excess cases. For each day  $d$  in the window, we compute the residual as the difference between the forecast ( $\mu_d$ ) and observed ( $x_d$ ) number of syndromic cases. We then sum the residuals over days in the ‘look back’ window to obtain an estimate of the disease burden (i.e., total number of non-diagnosed symptomatic anthrax cases),

$$C = \sum_{d=t-w+1}^t x_d - \mu_d.$$

To study the precision and accuracy of our estimates, we conducted a simulation study using ambulatory visit records for respiratory conditions. We used a model described previously [1] to simulate the daily increase in syndromic clinic visits and the time to first diagnosis through blood culture for outbreaks resulting from an aerosol anthrax release. We conducted 1,000 simulations for each of 12 scenarios defined by number infected (100-50,000 in a population of 428,000) and incubation model (based on data

from the Sverdlovsk and USA 2001 outbreaks). For each outbreak, we injected the simulated syndromic clinic visits into baseline data and estimated the disease burden at the time of the first clinical diagnosis. To ensure that an estimated increase in cases was not likely to be seen by chance, we accepted an increase as significant only if it was greater than 90% of estimates observed when there was no outbreak.

## RESULTS

Results are shown in Table 1 for estimation at the beginning of the day of the initial diagnosis. For 30,000 infected with the Sverdlovsk incubation model, the estimated number of cases is significant 24% of the time for a mean value of 173 and standard error of 117. The results are similar for 50,000 infections and worse for 10,000. Using the USA 2001 model, which has more tightly distributed incubation times, the estimate is significant more frequently. For 30,000 infected, the estimate is significant 61% of the time for a mean value of 399 and standard error of 84. The results are similar for 10,000 infections and better for 50,000. Computing the estimate at the end of the day of the initial diagnosis improves the results considerably (data not shown).

Number infected	Sverdlovsk Model			USA 2001 Model		
	Fraction significant	Mean estimated # of cases	Standard error	Fraction significant	Mean estimated # of cases	Standard error
10,000	11%	195	175	63%	334	88
30,000	25%	173	117	61%	399	84
50,000	24%	201	125	88%	277	73

Table 1: Estimated number of non-diagnosed symptomatic cases at the beginning of the day of initial clinical diagnosis ( $w=1$ ). Means and standard errors are for significant estimates.

## CONCLUSIONS

We have demonstrated a novel application of syndromic surveillance to estimate the outbreak size after detection of an inhalational anthrax attack. The estimates tend to be significant if the incubation time distribution is tight (e.g., as in USA 2001) or if the estimate is calculated at the end of the day on which detection occurs.

## REFERENCES

- [1] Buckeridge D, *A Method for Evaluating Outbreak Detection in Public Health Surveillance Systems that Use Administrative Data*, Ph.D. Thesis, Stanford University Biomedical Informatics, 2005.
- [2] Walden J, Kaplan E, Estimating time and size of bioterror attack, *Emerg Infect Dis*, 10(7): 1202-1205, July 2004.

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