Modeling Clinician Detection Time of a Disease Outbreak Due to Inhalational Anthrax

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OBJECTIVE

We developed a probabilistic model of how clinicians are expected to detect a disease outbreak due to an outdoor release of anthrax spores, when the clinicians only have access to traditional clinical information (e.g., no computer-based alerts). We used this model to estimate an upper bound on the amount of time expected for clinicians to detect such an outbreak. Such estimates may be useful in planning for outbreaks and in assessing the usefulness of various computer-based outbreak detection algorithms.

METHODS

Based on the literature [1-5] and expert assessments, we modeled the two primary ways that we assume a clinician would diagnose a patient as having inhalation anthrax (IA). One way involves obtaining a chest radiograph that is supportive of inhalational anthrax (IA). Such results are typically available within hours of patient presentation. The second method for detecting IA is by way of a positive blood culture, which usually requires one to two days to identify the anthrax bacillus, if it is present.

Our clinician detection model assumes that patients with IA present with respiratory symptoms. The model contains three key types of probabilities: (1) the probability a specific case is detected by way of a chest radiograph, (2) the probability the case is detected by way of a blood culture, and (3) the probability IA is not detected in the case.

In order to derive an upper bound on clinician detection time, the model assumes that a patient is only seen by a health care provider once (no return visits) and each clinician diagnoses a given case of IA independent of his or her prior cases and independent of the activities of other clinicians.

We performed an analysis using simulated anthrax cases from a computer based simulation [6] that is based in part on results from [1]. We considered a range of four different possible amounts of anthrax spores that might be released. (The units of these amounts are not reported here in order to avoid providing information about expected time-to-detection for various spore amounts, which could pose some degree of security risk.)

RESULTS

The following table shows the results. The derived upper bound on clinician detection time varied from about 9 days for the smallest amount of assumed release to about 3 days for the largest amount.

Assumed amount of anthrax released	0.02	0.13	0.25	0.50	1.0
Estimated upper bound on the expected detection time in days	9.30	4.09	3.25	3.08	3.05

CONCLUSIONS

We estimate that an outdoor release of anthrax (over a range of release amounts) is expected to be detected by clinicians within nine days of the release. Such an estimate has at least two practical uses. First, if a computer-based detection algorithm has longer than a four-day expected detection time (when run on the same simulated cases), then the algorithm may not be helpful in detecting an actual outbreak. Second, the estimated clinician detection time can be used in planning for a worst-case scenario of a bioterrorist-induced anthrax release.

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