Reducing the Delay in Detecting an Influenza Epidemic with More Sensitive Case Detection Algorithms

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OBJECTIVE

This work uses a mathematical model of a plausible influenza epidemic to test the influence of different case-detection algorithms on the performance of a real-world syndromic surveillance system (SSS).

BACKGROUND

Measures aimed at controlling epidemics of infectious diseases critically benefit from early outbreak recognition [1]. SSS seek early detection by focusing on pre-diagnostic symptoms that by themselves may not alarm clinicians. We have previously determined the performance of various Case Detector (CD) algorithms at finding cases of influenza-like illness (ILI) recorded in the electronic medical record of the Veterans Administration (VA) health system. In this work, we measure the impact of using CDs of increasing sensitivity but decreasing specificity on the time it takes a VA-based SSS to identify a modeled community-wide influenza outbreak.

METHODS

The influenza epidemic model was created in Matlab (The Matworks, Natick, MA) for the 30 zip codes centered on Baltimore, MD. The model includes 3 components: 1) a deterministic epidemic comprising a coupled series of partial differential equations; 2) a spatial spread component that has both deterministic and stochastic aspects; 3) an age-structured probability matrix of whether an influenza case comes to medical attention at the VA. Modeled epidemics were injected into eight (8) real-world SSS datasets of Baltimore VA patients i.e. raw or background-substracted daily counts of ILI cases given by 4 different CD algorithms during a typical one-year period (8/02-8/03). CDs were as follows: CD1 = CDC's respiratory syndromic ICD-9 codes; CD2 = optimized ICD-9 codes; CD3 = CD2 OR expectorant orders; CD4 = CD3 OR increased temperature. Epidemics were detected by running the SatScan software [2] prospectively (both time-only and space-time analyses) each day, from the time of injection to the first day that included a significant cluster with a p-value of ≤ 0.001. To address changes in detection delays due to the seasonal variations in ILI, epidemic injection/detection routines were repeated for each week of the test year for all eight substrate datasets.

RESULTS

Base on a previous manual, gold-standard review of 5,127 sample VA records, the sensitivity and specificity of the ILI CDs were: CD1: 0.68, 0.97; CD2: 0.78, 0.96; CD3: 0.84, 0.95; CD4: 0.87, 0.94. Mean detection delays for each CD are illustrated in Figure 1. For each CD, the delay varied with the detection methodology, with time-only Satscan > space-time, and raw ILI counts > background-subtracted ILI counts. Detection delays decreased from 31-34 days for CD1 to 14-20 days for CD4. Mean minimal delays when all 4 detection methods were used in parallel each day decreased from 29, 14, 13 and 12 days for CD1 to CD4, respectively. These detection times, corresponded to 640, 74, 65 and 59 influenza cases in the community.

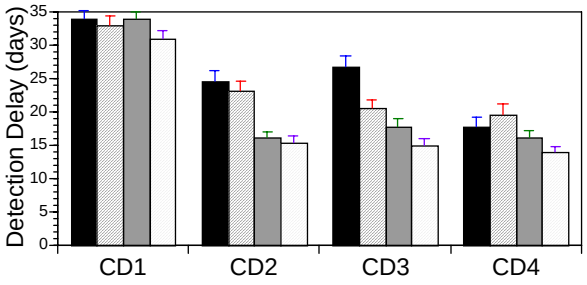

Figure 1 – Detection delays (y-axis) as a function of Case Detector algorithms (x-axis). For each CD, delay was measured using raw (filled bars) or background-subtracted (hatched bars) daily ILI count, using time-only (black bars) or space-time (grey bars) Satscan analyses. Each bar correspond to the mean +/- SEM delay in detecting 52 epidemics, each injected on a different week.

CONCLUSIONS

Even when associated with modest decreases in specificity, increasing the sensitivity of case detection can shorten the time it takes a SSS to recognize an influenza epidemic.

REFERENCES

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