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ABSTRACT

A collaboration to enhance detection of disease outbreaks clustered by time of patient arrival

H Burkom[1], L Ramac-Thomas[1], R Arvizu[1], C Lee[1], W Loschen[1], R Wojcik[1], and A Kite-Powell[2]

[1]*Johns Hopkins University Applied Physics Laboratory, National Security Technology Department, Baltimore, MA, USA; and* [2]*Florida Department of Health, Bureau of Epidemiology, Tallahassee, FL, USA*
E-mail: howard.burkom@jhuapl.edu

Objective
This presentation discusses the approach and results of collaboration to enable a solution of a hospital time-of-arrival (TOA) monitoring problem in syndromic surveillance applied to public health data at the hospital level for county monitoring.

Introduction
One objective of public health surveillance is detecting disease outbreaks by looking for changes in the disease occurrence, so that control measures can be implemented and the spread of disease minimized. For this purpose, the Florida Department of Health (FDOH) employs the Electronic Surveillance System for Early Notification of Community-based Epidemics (ESSENCE). The current problem was spawned by a labor-intensive process at the FDOH: authentic outbreaks were detected by epidemiologists inspecting ESSENCE time series and derived event lists. The corresponding records indicated that patients arrived at an ED within a short interval, often less than 30 minutes. TOA task was to develop and automate a capability to detect events with clustered patient arrival times at the hospital level for a list of subsyndrome categories of concern to the monitoring counties.

Methods
Factors that drove the choice of the statistical alerting algorithm for the TOA surveillance were: user objectives and processing performance needs, the existing ESSENCE operational framework, and the limitation to time series and covariates that could be extracted quickly with ESSENCE queries.

The chosen approach was to monitor each of the many time-series cells, in which cells could be stratified by several variables. Following analysis of the influence of selected variables in historical data, a cell was defined as a hospital/syndrome/time-of-day combination (Figure 1). For the majority of these cells, a Poisson distribution test was applied, and a negative binomial test was applied for cells whose time-series counts were overdispersed. The method adjusts for daily patterns and for levels of activity that vary widely across hospitals.

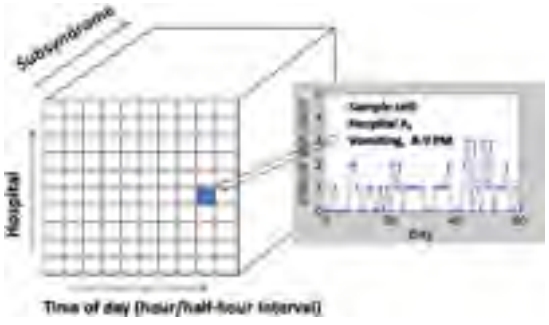

Figure 1 Schematic depicting the temporal cell-based monitoring method.

Results
This method was tested and validated on ED visit count data covering over 6 years and aggregated at 30-minute intervals for 51 subsyndromes from each of 134 hospitals covering 34 Florida counties.

An alerting threshold of $P = 0.0001$ gave detection of 18 of the 20 known signals in the data, with manageable alert counts for the most common subsyndromes in the largest hospitals. This method is implemented in an operational ESSENCE website module.

Conclusion
The TOA application resulted from (a) a well-defined problem and associated constraints; (b) involvement of all stakeholders for the duration of the project, including a state-level epidemiologist domain expert; and (c) data streams sufficient for a useful solution. The approach and implementation were the result of a give-and-take process informed by data analysis, with features that were informative for the efficiency of future collaborative efforts.

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