

Increase in Pneumonia Cases as an Early Indicator of Severe and Pandemic Influenza Outbreak

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Objective

To enable the early detection of pandemic influenza, we have designed a system to differentiate between severe and mild influenza outbreaks. Historic information about previous pandemics suggested the evaluation of two specific discriminants: (1) the rapid development of disease to pneumonia within 1-2 days and (2) patient age distribution, as the virus usually targets specific age groups [1]. The system is based on the hypothesis that an increased number of diagnosed pneumonia cases offers an early indication of severe influenza outbreaks. This approach is based on the fact that pneumonia cases will appear promptly in a severe influenza outbreak and can be diagnosed immediately in a physician office visit, while a confirmed influenza diagnosis requires a laboratory test. Furthermore, laboratory tests are unlikely to be ordered outside of the expected influenza season.

Methods

Data are collected by ESSENCE (Electronic Surveillance System for the Early Notification of Community-Based Epidemics) from civil and military outpatient office and hospital emergency room (ER) visits in selected counties in Virginia and Maryland, and these data have been used to detect past influenza outbreaks. The system's data inferring model consists of two steps. First, the system processes the data using algorithms currently deployed by ESSENCE [2] to detect statistical anomalies within each of the data streams. Second, a Bayesian network model fuses anomalies from all data streams to identify patterns suggesting outbreaks. This network is structured to calculate the likelihood of a severe influenza outbreak based on the joint probability of finding pneumonia in infants, children, adults and the elderly. This structure allows recognition of full and partial outbreak patterns within each age group. Diagnosed pneumonia, respiratory and fever syndromes, demography, and hospital admission information serve as data sources for the input nodes for each group. On any given day, each input node reflects the status of one of the data streams, either normal or abnormal depending on the presence of an anomaly.

Results

Our research demonstrates a strong correlation between increases in pneumonia data counts and

severe influenza outbreaks. Bayesian data fusion of the diagnosed pneumonia cases with respiratory syndrome data shows high sensitivity, and significantly increases the specificity of the system. Figures below show Montgomery County influenza activity and the detection of outbreaks in 2003-2004, and 2004-2005. The 2005-2006 influenza was very mild in Maryland as shown by the confirmed number of influenza cultures in Figure 1.

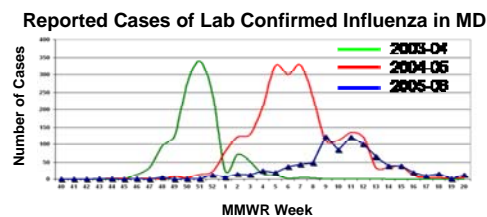


Figure 1. Laboratory confirmed influenza cases.

Figure 2 shows the alarms compared to outpatient ICD9-487 influenza diagnoses, and counts of emergency room (ER) visits with influenza like illness (ILI) symptoms.

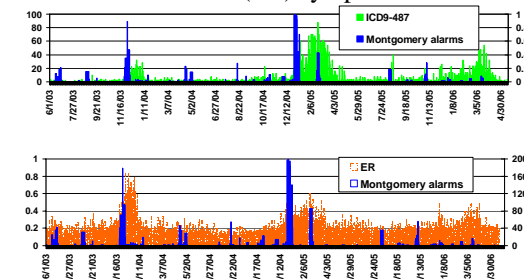


Figure 2. Alarms, influenza ICD9-487 and ER visits with ILI symptoms for Montgomery County.

Conclusions

Preliminary analysis has shown pneumonia to be a potential early indicator for severe influenza outbreaks.

References

- [1] Barker WH, Mullooly JP. Impact of epidemic type A influenza in a defined adult population. *Am J Epidemiol.* 1980 Dec;112(6):798-811.
- [2] Lombardo JS, Pavlin JA, et al., 2003: A systems overview of the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE II), *J Urban Health, Vol. 80(2 Suppl 1):i32-42.*
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