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Emergency Department Syndromic Surveillance for Novel H1N1 Spring 2009

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Abstract

Purpose—To demonstrate the utility of Emergency Department syndromic surveillance in the setting of a novel and unexpected H1N1 influenza outbreak.

Basic procedures—Data collection from emergency department electronic medical records was used to track initial Chief Complaint (CC) and discharge ICD-9 codes related to Influenza Like Illness (ILI). An alert threshold was generated using cumulative sum sequential analysis technique. The data was retrospectively analyzed to identify alerts that correlated with Novel Influenza H1N1 illness.

Main Findings—Our system alerted for ILI earlier than both the official national CDC press release for novel H1N1 and the first laboratory confirmed case in our county.

Principal conclusions—Emergency Department syndromic surveillance can be used to detect novel and unexpected ILI before laboratory confirmation and serve as an adjunct to traditional laboratory guided public health alerts. Early identification of increased ILI activity may allow emergency department health care providers the ability to perform more efficient and effective targeted laboratory testing and deploy isolation measures more quickly.

Keywords

H1N1 Virus; Swine-Origin Influenza A H1N1 Virus; Syndromic Surveillance; Emergency Medicine; Public Health Surveillance

Introduction

Syndromic surveillance is an adjunct to traditional public health surveillance that allows epidemiologists and infectious disease practitioners to identify acute disease outbreaks by monitoring groupings of health care data such as ICD-9 or chief complaints. Examples of such groupings include Influenza-Like-Illness (ILI), Respiratory and Gastrointestinal syndromes(1;2). Syndromic surveillance also relies on many pre-diagnostic data sources such as over-the-counter pharmaceutical sales, school or work absenteeism, calls to health care hot-lines and visits to health care providers to identify potential disease outbreaks (3-5). Historically, Emergency Department (ED) health care data has been shown to be useful for public health disease surveillance (2;6;7) Emergency Department surveillance systems can not only provide early warning to public health officials but provide advanced warning of unusual trends in illness to ED personnel allowing more timely, proactive steps in patient isolation and situational awareness.

Emergency Departments are often the front lines of health care for many who become seriously ill, are unable to be acutely seen by a primary care provider or are uninsured. Thus, Emergency Departments see a wide range of acute illness and will undoubtedly be involved in the evaluation and treatment of those who are acutely ill during a local disease outbreak, epidemic or pandemic. In addition to caring for a variety of disease, emergency physicians are under increasing pressure to limit laboratory testing to provide more cost effective medicine.

Activity for the early 2008-2009 influenza season was typical with a rise in activity noted in early January. Activity peaked from the 6th through the 8th week of 2009 with the predominant types being seasonal A (H1N1) and Influenza B. During the 15th week of influenza season the accounts of influenza continued to trend downward and it appeared that the influenza season would soon be over.

On April 23rd, 2009, during the 16th week of influenza season, a CDC press release informed the public of an unusual outbreak of ILI that was identified in Mexico. Two additional cases were identified in the southwestern United States. This causative agent was later identified as a novel H1N1 virus (8-11). The emergence and rapid spread of this novel virus would later prompt the World Health Organization to declare a new Influenza Pandemic.

Influenza pandemics have occurred three times in the past century; in 1918-19, 1957-58, and 1968-69. Historically these pandemics have been preceded by a mild form of the virus in the spring with the more virulent virus disseminating in fall. This early phase of the current H1N1 pandemic may be a precursor to more serious and widespread activity of the influenza virus later this year.

The purpose of this article is to describe the performance of Emergency Department syndromic surveillance for ILI during the novel H1N1 Influenza outbreak. Emergency Department syndromic surveillance may serve as a more timely notification system alerting public health and medical professionals to novel and unexpected disease patterns. Thus, such systems may allow Emergency Department personnel to be more proactive in patient isolation and implement more efficient and appropriate testing.

Methods

This study was performed in an urban academic emergency department with an annual volume of approximately 40,000 patients. Documentation at our facility is done through EPIC ASAP (Epic Systems Corporation Madison WI). Patient data including chief complaint and diagnosis are entered at the time of initial presentation and discharge, respectively. All diagnosis are automatically linked through the electronic medical record (EMR) to ICD-9 codes resulting in real time availability of such codes for syndromic surveillance. A standardized list of both chief complaints and diagnostic codes are embedded in the EMR.

A limited data set including patient encounter date, time, age, chief complaint and ICD-9 discharge diagnosis are automatically and securely transferred to our surveillance server via the Secure File Transfer Protocol by 10 a.m. every morning. Unique HIPAA patient identifiers such as medical record number or date of birth are not included in the data set. Surveillance data is transferred in Comma Separated Value (CSV) file format and reflects the previous 24 hours of Emergency Department patient encounters. The file is automatically imported into a MySQL open source database.

Data was retrospectively gathered from September 1, 2008 through May 27th, 2009. The database was queried to count daily chief complaint and discharge diagnosis related to ILI. The definitions used for this study are listed in Table 1 and 2. ICD-9 codes were based on and modified from CDC syndrome definitions for ILI. Chief complaints were chosen from a standardized list embedded in the EMR to best reflect ILI. The sum of the Chief Complaints or ICD-9 codes were reported for each day. For example, 4 complaints of cough, 3 fever and 3 muscle aches within a 24 hour time frame would result in an ILI syndrome count of 10 for that day. The same was performed for the ICD-9 data stream. This information was exported back into CSV file format.

A modified sequential analysis technique CUSUM (**cumulative sum**) was used to calculate an alert threshold for the date of interest (12). This alert threshold was compared to the date of interest's actual counts. If the date of interest's counts equaled or exceeded the alert threshold an alert was generated.

In order to determine the alert value, the previous 7 consecutive day's average syndrome counts, displaced by 3 days, was used to calculate the threshold. For example, if the date of interest was October 15th then the average of the daily counts from October 6th through 12th were used in the calculation. The 7 day data range was displaced by 3 days in order to decrease the dilutional effect of any gradual consecutive rise in counts near the day of interest. Common thresholds of 2.5 – 3 times the standard deviations above the mean are used for heightened and routine syndromic surveillance. Values closer to 3 reduce false positive alerts but also decrease sensitivity of the surveillance system. Our alert threshold was defined as 2.5 Standard Deviations above the calculated mean. (Figure 1)

A computer program was written in the PHP programming language (www.php.net) to read daily syndrome counts from the CSV file, calculate the alert threshold and flag if the daily count met or exceeded the threshold. Graphs representing daily syndrome counts and alert dates were generated using the R statistical package version 2.8.0 (R Foundation for Statistical Computing).

Results

Alerts for ILI occurred on April 18th (Daily Count 17 / Alert Threshold 12) and 29th (Daily Count 18 / Alert Threshold 15) using the ICD-9 data stream. These alerts were associated with a overall increase in ICD-9 ILI associated diagnosis over the previous 2 weeks. The April 18th alert occurred 5 days prior to the first official CDC press release on April 23rd 2009 (PR) and 18 days prior to the first confirmed case of novel H1N1 in our county on May 6th 2009 (CD). (Figure 2). An alert for ILI using the Chief Complaint data stream (Daily Count 24 / Alert Threshold 24) coincided with the April 29th ICD-9 signal and occurred 7 days prior to the first laboratory confirmed case of H1N1 in our county (Figure 3). Data from the 2007-2008 seasonal influenza season is included as an example of disease activity in a typical flu season (Figure 4).

Discussion

Syndromic surveillance using Chief Complaint and ICD-9 discharge diagnosis indicated a rise in ILI activity one to two weeks earlier than laboratory confirmation of cases of novel H1N1 in our county. This has important implications for emergency department operation and public health in the detection of unexpected disease outbreaks.

Traditional surveillance methods rely heavily on laboratory testing and physician reporting of disease activity. Emergency physicians often rely on clinical acumen in order to minimize testing and expense. In fact, the CDC recommends that testing be prioritized for those with

severe respiratory illness and those at highest risk of complications from influenza (13). This may lead to delayed and under-reporting of new disease activity of an unexpected outbreak. Advanced warning generated by syndromic surveillance systems for ILI may allow health care providers and public health officials to perform more efficient and early laboratory testing for respiratory illness.

Several hospital systems have advanced integrated syndromic surveillance that use real time emergency department or telephone triage chief complaints to alert public health officials to potential disease outbreaks. There has been retrospective demonstration of the early warning benefit of using emergency department discharge diagnoses compared to traditional laboratory testing surveillance for influenza (14). With the implementation of statistical methods for space-time cluster detection, such as cumulative sum (CUSUM) analysis, practitioners and public health officials can prospectively analyze emergency department data generated in real-time (15). To our knowledge this manuscript is the first to describe how a syndromic surveillance system can work in an unexpected influenza outbreak.

The CUSUM method was effective in identifying statistically significant spikes in ILI activity; however, the alarms were considered to be true positives only when associated with an increasing trend. There were several false positives throughout the year that were not correlated with a confirmed influenza outbreak. Thus, human analysis of the data associated with an alert is necessary to determine the likelihood of a true outbreak.

While the CUSUM method was effective in identifying aberrant spikes in ILI activity, attention to graphical trends is also central to effective monitoring for disease. A large increase in ILI activity was identified on 04/18/2009 within the ICD-9 data stream. Fortunately, this abrupt increase in counts occurred during the early increase in slope of the graph. This was not the case within the chief complaint data stream where an abrupt rise in activity occurred near the apex of activity. Early identification of aberrant ILI activity could also have been detected by daily visual inspection of the graphs noting a gradual but significant rise in counts.

Increased Emergency Department visits for respiratory illness may be attributed to the widespread press coverage of the novel H1N1 virus. However, our system demonstrated an upward trend and also alerted 5 days prior to the CDC press release. Thus, this makes a false positive trend of worried well unlikely.

We postulate that the addition of syndromic surveillance to traditional surveillance methods can enhance disease outbreak detection. Advanced warning generated by such systems for ILI may allow health care providers to perform more efficient and early laboratory testing for disease confirmation or identification of new strains of respiratory pathogens.

Early detection may also increase vigilance within the emergency department by prompting health care providers to place patients in respiratory isolation and increase use of personal protective equipment. This may decrease transmission of both common respiratory viruses and potentially more serious pathogens both among patients and health care workers. Appropriate safeguards may decrease provider illness and decrease the likelihood of staff shortages during an outbreak. If such systems are linked to public health, early identification of a rise in ILI activity may prompt more aggressive and appropriate investigation of disease outbreaks.

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Figure 1.

Example of calculation of Alert Threshold using a modified CuSUM technique.

Figure 2. ICD-9 Data Stream for 2008-2009 Influenza Season

This figure shows the daily counts, the CUSUM line (_____) and the CUSUM + 2.5 standard deviation alerting threshold line (....). Exceeded alert threshold dates are depicted in red. First alert for H1N1 season occurred on April 18th, the second alert occurred on April 29th. The CDC press release for H1N1 cases in the United States occurred on April 23rd (PR), and the first laboratory confirmed case occurred on May 6th. (CD)”

Figure 3. Chief Complaint Data Stream for 2008-2009 Influenza Season

This figure shows the daily counts of ILI chief complaint, the CUSUM line (____) and the CUSUM + 2.5 standard deviation alerting threshold line (....). Exceeded alert threshold dates are depicted in red. The only alert for H1N1 season occurred on April 29th. The CDC press release for H1N1 cases in the United States occurred on April 23rd (PR), and the first laboratory confirmed case occurred on May 6th (CD).

Figure 4.
ILI activity for typical influenza season 2007-2008

Table 1

Any one of the listed diagnostic codes would generate a syndrome count for the patient encounter

Influenza-Like-Illness ICD-9 Syndrome Definition	
487.00	INFLUENZA WITH PNEUMONIA
487.10	INFLUENZA W/OTH RESP MA
487.80	INFLUENZA W/OTHER MANIFEST
79.99	VIRAL INFECTIONS UNSPECIFIED
79.89	VIRAL INFECTION OTHER S
780.60	FEVER
490.00	BRONCHITIS NOS
486.00	PNEUMONIA NOS
465.80	URI OTHER MUL SITES
465.90	URI ACUTE NOS
466.00	BRONCHITIS ACUTE
786.20	COUGH
460.00	NASOPHARYNGITIS ACUTE
485.00	BRONCHOPNEUMONIA ORGANISM
461.90	ACUTE SINUSITIS UNSPECIFIED
466.19	BRONCHITIS ACUTE DT OTHER ORGANISM

Table 2

Any one of the listed complaints would generate a syndrome count for the patient encounter

Influenza-Like-Illness Chief Complaint Syndrome Definition
Fever
Cough
Headache
Fatigue/Malaise
Muscle Pain
URI Symptoms
Viral Illness
Body Aches
Sore Throat
Chills