DESCRIPTION OF AN EMERGENCY DEPARTMENT-BASED SYNDROMIC SURVEILLANCE SYSTEM IN LOS ANGELES COUNTY*

BACKGROUND

The anthrax attacks of 2001 and the recent outbreaks of severe acute respiratory syndrome (SARS) and influenza strikingly demonstrate the continuing threat from illnesses resulting from bioterrorism and emerging infectious diseases [1,2]. In particular, these outbreaks have highlighted that an essential component of preparations for illnesses and syndromes potentially related to bioterrorism includes the deployment of surveillance systems that can rapidly detect and monitor the course of an outbreak with the goal to minimize associated morbidity and mortality. Prior to these events, most health departments relied on passive reporting of infectious disease, estimates of disease from secondary sources, self-reported disease from population surveys, or anecdotal information conveyed by colleagues to track emerging diseases. Unfortunately, this information often comes in sporadically or is sufficiently delayed such that response efforts can be severely hindered. In order to respond more effectively to suspect illness and potential disease outbreaks, better methods for timely detection must be developed [3].

Driven by the threat of additional outbreaks resulting from bioterrorism and the increasing availability of data available for surveillance, surveillance systems have proliferated. Many health departments across the nation have begun diverse surveillance systems. For instance, Connecticut monitors admissions to all its acute hospital and visits to emergency departments to detect bioterrorism events [4], Massachusetts utilizes ambulatory-care encounters [5], and New York City analyzes data from fifteen sentinel emergency departments [6]. Many other health departments and medical centers are currently researching and implementing similar systems. In addition to emergency departments, other possible sources may include community physicians, public health laboratories, school and work force absenteeism, pharmaceutical and over-the-counter sales [7], nurse hot line call [8], and nursing homes [9].

The ACDC began an infectious disease surveillance project in the fall of 2001. This system relied principally upon chief complaint data, from patient records of selected emergency departments (ED), organized into syndromes of interest. The syndromes were chosen to represent the chief complaints that would be expected in outbreaks of infectious diseases (respiratory symptoms, fever, rash, gastrointestinal symptoms) Use of chief complaint data, which is patient-derived and recorded as soon as the patient presents to the ED, was appropriate because it has been shown to have good agreement with final diagnosis, which is physician-generated—and therefore often takes considerably longer to be recorded and received by the surveillance system [10]. Utilizing chief complaint data also offered the advantage of rapid implementation, since all hospitals are required to maintain logs, and would have the potential to expand into a regional system of surveillance. In addition, many chief complaint logs already exist in electronic form and are immediately available, whereas diagnostic information may require additional time for coding, be entered at a later time, or exist in paper format only.

We collected ED chief complaint information from three hospitals in Los Angeles County (LAC) to provide early recognition of an increase or clustering of disease syndromes that might be indicative of a disease outbreak, whether natural or intentional. The following describes the LAC emergency department-based surveillance system for the period January 1, 2003 through December 31, 2003.

METHODS

<u>Data Sources and Syndrome Categories</u>: Staff from ACDC receive emergency department logs daily from three large metropolitan hospitals in the City of Los Angeles (Hospital 1, Hospital 2, and Hospital 3). For each daily log received, the patient's identification number, age, sex, chief complaint, and final diagnosis

* Adapted from Velikina R, Jones J, Aller R, Reynaldo S, et al. Description and Evaluation of an Emergency Department-Based Syndromic Surveillance System in Los Angeles County (*in development*).

are entered into a database. Patient chief complaints are then classified into one of four categories: gastrointestinal (GI), respiratory, rash or neurological. The GI category includes complaints of nausea, vomiting, or diarrhea alone or together with gastritis or gastroenteritis. A complaint is categorized as respiratory if it includes influenza, acute bronchitis, acute pharyngitis, acute laryngitis, pneumonia, cough, viral syndromes, upper respiratory infections, sore throat, or acute sinusitis. Rash includes all rash complaints other than urticaria, hives, scabies, dermatitis, cellulitis or allergic reaction. Finally, a complaint is categorized under the neurological category if it includes new onset seizures, symmetrical facial paralysis/drooping, encephalitis, or meningitis. For data processing, syndrome coding and data management SAS software is utilized. The syndrome-coding algorithm is designed to capture the wide variety of misspellings and abbreviations in the chief complaint field.

<u>Data Analysis:</u> A 30-day baseline was established for each of the four syndromes to detect fluctuations in the number of visits due to natural or unnatural events. A 30-day baseline was chosen because it provides a comparison with minimal variation (as opposed to the previous day or week) but is still sufficiently sensitive to detect an event. If the current day observation exceeds 2 or 3 standard deviations (SD) beyond the previous 30-day average, a “signal” will be generated. The signal generated from the 30-day average plus 3 SDs results in a more conservative alarm system than the 30-day average plus 2 SDs. Analyses were conducted using both methods, in part to evaluate the optimal method for specific syndrome detection in LAC.

IF [Average count from previous 30 days **+** 2 or 3 standard deviations from previous 30 days] **<** [Current day’s count] **THEN** → **“SIGNAL”**

Positive signals are investigated by the ACDC clinical and epidemiological staff. If further clarification is necessary, the hospital infection control practitioner (ICP) is contacted to further investigate the case(s). If an unusually high number of cases is associated with a signal, emergency room staff are contacted for more detailed information on patient symptoms, disease progress, lab tests, and final disposition to determine whether the signal represents a one-day event or the beginning of an upward trend.

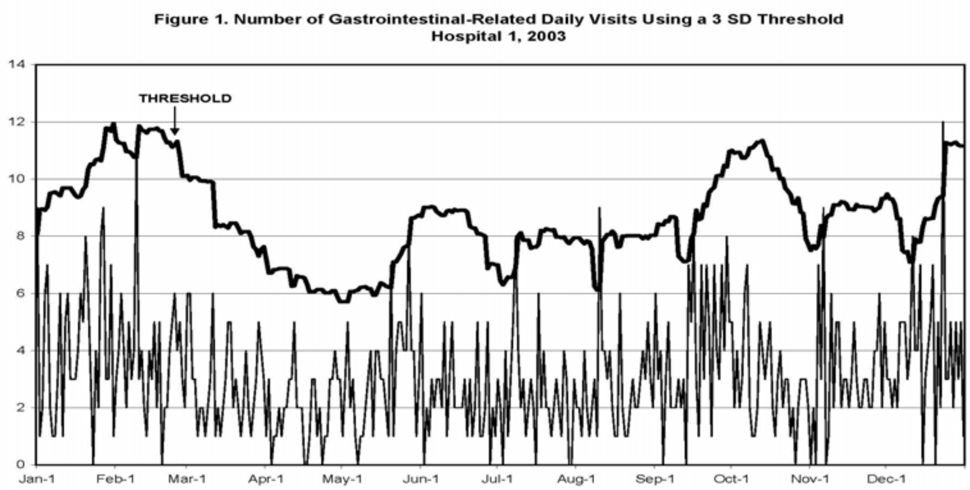
RESULTS

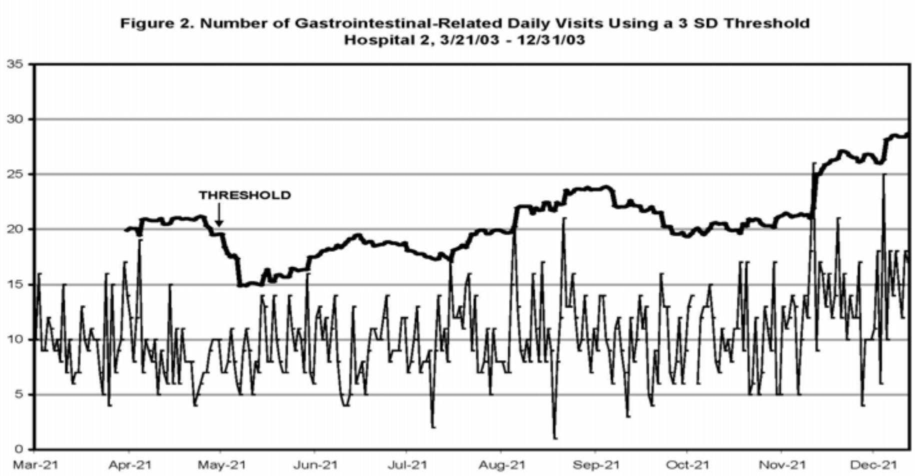
For 2003, Hospital 1 had a total of 33 signals utilizing the more conservative method (3 SDs) and 78 utilizing the less conservative method (2 SDs) across the syndromic categories (Table 1). Hospital 2 had 15 signals using the more conservative method and 64 using the less conservative method across the syndromic categories (Table 1). Hospital 3 had 50 signals using the more conservative method and 20 using the less conservative method across the syndromic categories (Table 1). Gastrointestinal visits fluctuated throughout the year, while respiratory visits peaked in the winter months and then began to decline, after which they picked up again around November. There were very few rash- and neurological-related visits, with no apparent seasonal trend.

Table 1. Number of Signals by Site, Syndrome and Signal Type, 2003

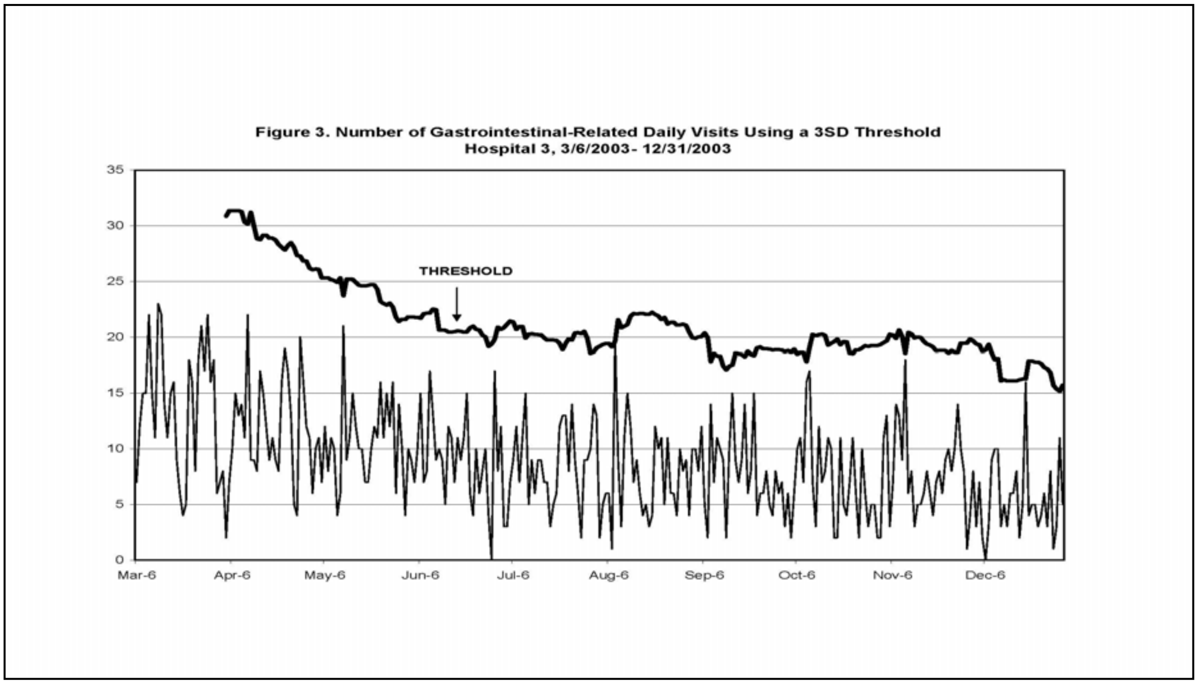
	Hospital 1		Hospital 2		Hospital 3	
Syndrome	**2 SD**	**3 SD**	**2 SD**	**3 SD**	**2 SD**	**3 SD**
Gastrointestinal	21	9	14	2	9	1
Neurological	11	10	19	5	5	5
Rash	20	7	17	3	18	9
Respiratory	26	7	14	5	18	5
TOTAL	**78**	**33**	**64**	**15**	**50**	**20**

<u>Gastrointestinal-Related Visits</u>: There were a total of 1,664 gastrointestinal-related visits in 2003 from Hospital 1, 3,050 from Hospital 2, and 3,197 from Hospital 3. Hospital 1 had 21 signals using a 2 SD method and nine signals using a 3 SD method (Figure 1). Hospital 2 had 14 signals using a 2 SD method and two signals using a 3 SD method (Figure 2). Hospital 3 had nine signals using a 2 SD method and one signal using a 3 SD method (Figure 3). The following figures display findings based on a 3 SD cut-off.

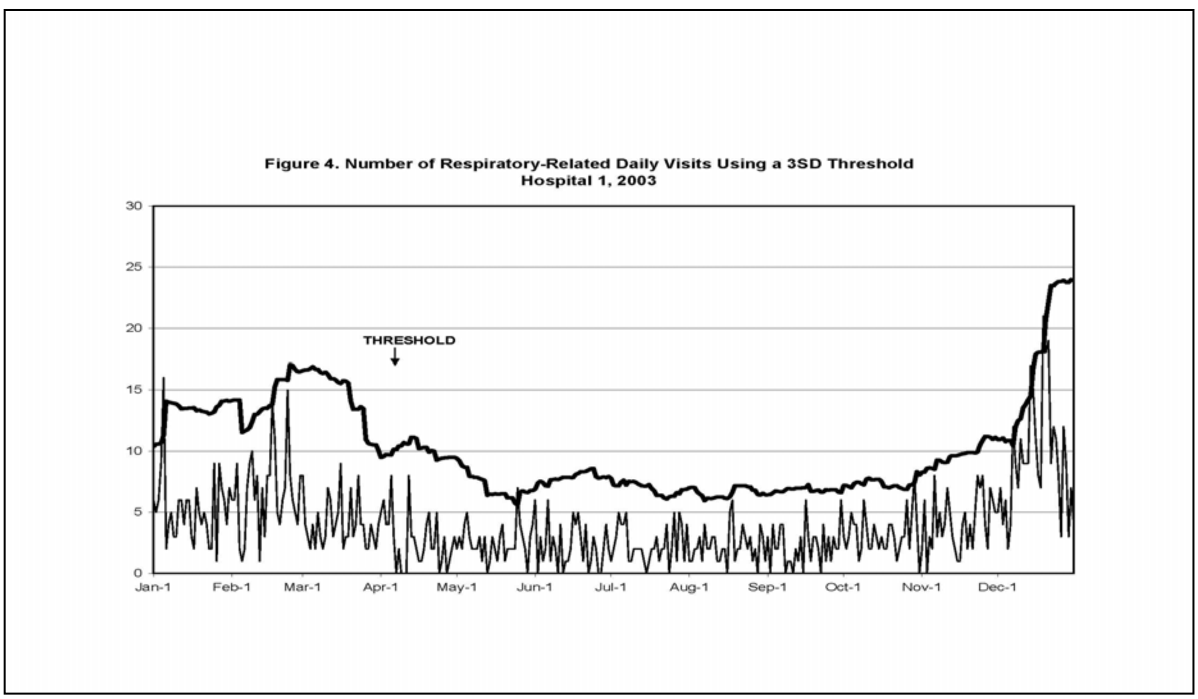


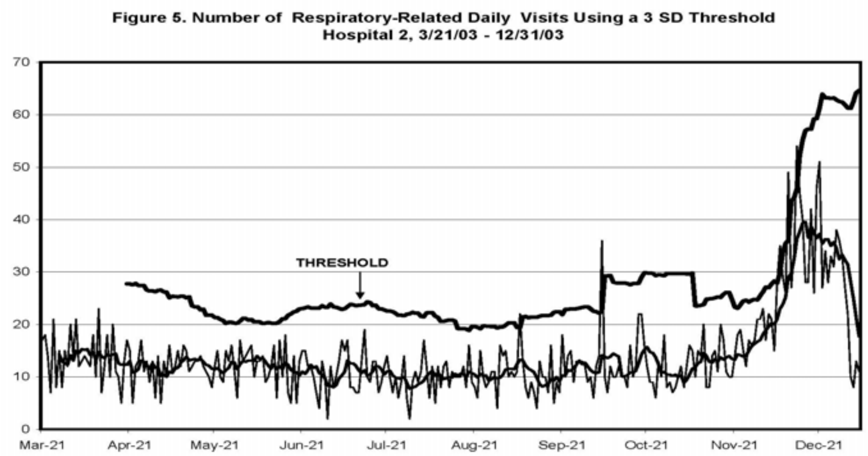


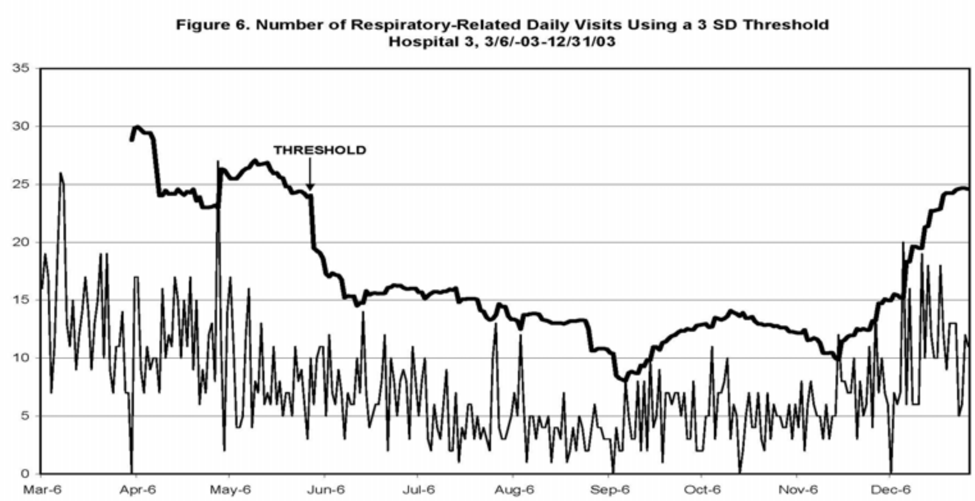
Hospital 3 had nine signals using a 2 SD method and one signal using a 3 SD method (Figure 3). The following figures display findings based on a 3 SD cut-off.



<u>Respiratory-Related Visits</u>: There were a total of 1,824 respiratory-related visits in 2003 from Hospital 1, 2,266 from Hospital 2, and 2,730 from Hospital 3. Hospital 1 had 26 signals using a 2 SD method and 7 signals using a 3 SD method (Figure 4). Hospital 2 had 14 signals using a 2 SD method and five signals using a 3 SD method (Figure 5). Hospital 3 had 18 signals using a 2 SD method and five signals using a 3 SD method (Figure 6).







Neurologic-Related Visits: There were total of 36 neurologic-related visits in 2003 from Hospital 1, 76 from Hospital 2, and 18 from Hospital 3. There were 11 signals using a 2 SD method and 10 signals using a 3

SD method for Hospital 1. Hospital 2 had 19 using a 2 SD method and five signals using a 3 SD method. Hospital 3 had five signals using a 2 SD and five signals using a 3 SD method.

Rash-Related Visits: There were a total of 346 rash-related visits in 2001 from Hospital 1, 804 from Hospital 2, and 85 from Hospital 3. There were 20 signals using a 2 SD method and 7 signals using a 3 SD method for Hospital 1. Hospital 2 had 17 using a 2 SD method and three using a 3 SD method. Hospital 3 had 18 signals using a 2 SD method and nine signals using a 3 SD method.

DISCUSSION

Our syndromic surveillance system has proven to be a useful tool in the detection of emerging infectious disease outbreaks. All three hospitals exhibited an increase in respiratory cases in the beginning of November 2003, heralding the start of flu season in LAC. In addition, our system was able to detect an increase in GI cases among children in Hospital 2. Further investigation revealed an outbreak of rotavirus in the community. The fundamental goal of syndromic surveillance is early detection of potential bioterrorist events or emerging infectious disease outbreaks, not to diagnose individual cases or to find cases of reportable disease; however, as demonstrated by our system, it can also be used to detect community outbreaks. The timely use of automated chief complaint data, especially with detection algorithms, may be a valuable resource for supplementing current infectious disease surveillance systems.12 Further refinement of the system, such as expanded analysis and increased coverage, will further enhance the capabilities of our syndromic surveillance system.

Syndromic surveillance has the potential to become a useful tool. Establishing such a system can be cost-efficient, since all hospitals are required to maintain an ED log [11]. Syndromic surveillance also has the ability to assess a large number of episodes of illness for which no etiologic agents are identified, either because standard medical practice does not require that clinicians perform diagnostic tests, or because an unusual agent may fail to be detected by standard laboratory tests [12]. It is important to note that the specificity of an individual illness categorized as a “syndrome” need not be high, provided it is constant over time. The goal of a syndromic surveillance system is, but to detect emergent disease situations as rapidly as possible. Advantages include circumventing the need for providers to initiate reporting and easy manipulation of the system for data analysis [11]. Finally, syndromic surveillance has been shown to detect patterns and outbreaks that were not detected by traditional surveillance systems [13].

One important limitation is that syndromic surveillance is not sufficiently sensitive to detect an individual case. Because the surveillance system is based on a baseline of the number of cases of a particular syndrome during the previous 30 days, an individual case, even if due to bioterrorism, may not be sufficient to trigger a signal. Instead, a large outbreak of a particular syndrome that would result in a considerable increase in the number of patients seen in an ED would be necessary to produce a signal. Furthermore, sensitivity depends heavily on the syndrome. The surveillance system may require a large outbreak to detect the use of a gastrointestinal- or respiratory-related bioterrorist agent, but may require only 1–3 cases to detect a rash-or neurological-related agent, such as botulism, smallpox, or encephalitis since the frequency of neurological and rash syndromes is low. The system may be useful for the respiratory or gastrointestinal syndromes, including anthrax, plague or tularemia, only if they affect a wide geographic range and affect many individuals who seek care in an ED.

Therefore, the ability of syndromic surveillance to detect an infectious disease outbreak or bioterrorist event must be determined, whether through drills, models, real-life situations or other tools, before further refinement, such as complete automation, may be considered. Furthermore, demonstrated dual use benefits of syndromic surveillance would aid in establishing it as an integral to infectious disease detection. Until the system is established as a reliable tool, alert health care professionals will remain crucial to the early detection and timely response to infectious diseases.

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