

EMERGENCY DEPARTMENT SYNDROMIC SURVEILLANCE AND POPULATION-BASED HEALTH MONITORING IN LOS ANGELES COUNTY

BACKGROUND

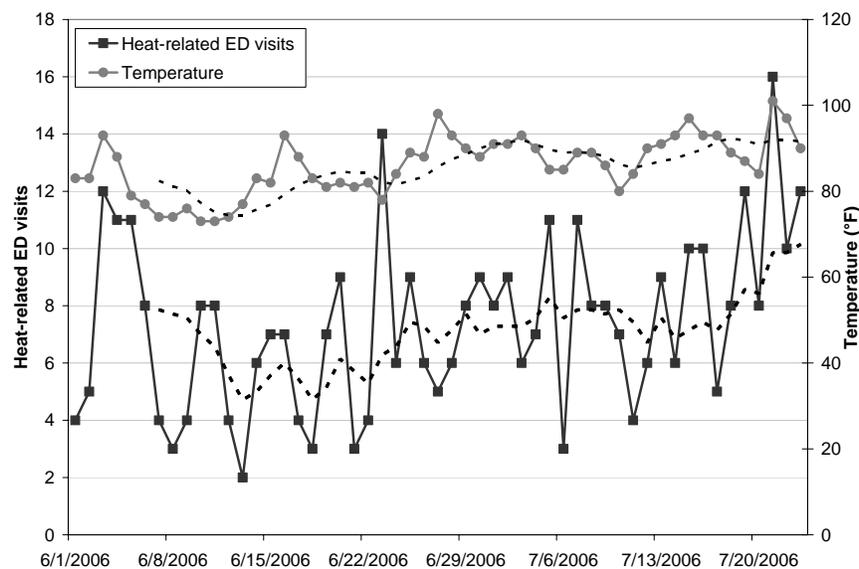
The Bioterrorism (BT) Surveillance Unit of the Los Angeles County (LAC) Department of Public Health (DPH), Acute Communicable Disease Control (ACDC) program analyzes Emergency Department (ED) data on a daily basis. The development of this system was primarily for early event detection and surveillance of ongoing health events in near real-time. Currently, the hospital EDs participating in syndromic surveillance monitor over 40% of the ED visits in LAC. Through an automated process, ED data from the previous day are collected and evaluated for aberrations in count and spatial distribution by utilizing the Centers for Disease Control and Prevention (CDC)'s Early Aberration Reporting System and SaTScan™ statistics. ED admitting chief complaints are classified using a SAS-based language processing code into five major syndrome categories: gastrointestinal, neurological, rash, respiratory, and influenza-like illness. Other complimentary systems used for surveillance include: Reddinet, which provides a daily tabulation of total ED visits from 65 participating hospital EDs, as well as ED-related hospital admittances, ICU admittances, and deaths; over the counter medicine sales provided by the Real-time Outbreak and Disease Surveillance laboratory; and LAC Coroners' mortality data. A daily report summarizing syndromic surveillance results and any signals generated is sent to key stakeholders seven days a week.

The syndromic surveillance system is automated, near real-time, population-based, and enables the surveillance of health indicators that would otherwise be difficult if not impossible for both hospital and ACDC staff. Typical usage of the system may be extended for various enhanced surveillance activities by creating additional syndrome categories tailored to specific illnesses or conditions. This report describes examples of how ED data was harnessed in 2006 to detect and monitor ED visits related to: 1) a summer heat wave, 2) a beach sewage spill, and 3) *E. coli* associated with contaminated bagged spinach. These examples demonstrate the flexibility of syndromic surveillance in capturing ED visits related to infectious and non-infectious, broadly defined and specific illnesses.

METHODS

Heat-related ED visits: While June 2006 was characterized by relatively normal temperatures for the month, July 2006 was the warmest July on record in many parts of California, during which a sustained heat wave caused a flood of ambulance calls, hospitalizations, and deaths due to heat-related illnesses [4]. Temperatures in LAC varied by region—downtown Los Angeles experienced 17 days during which maximum temperatures met or exceeded 90 degrees, while Woodland Hills experienced 24 days of triple digit temperatures [5].

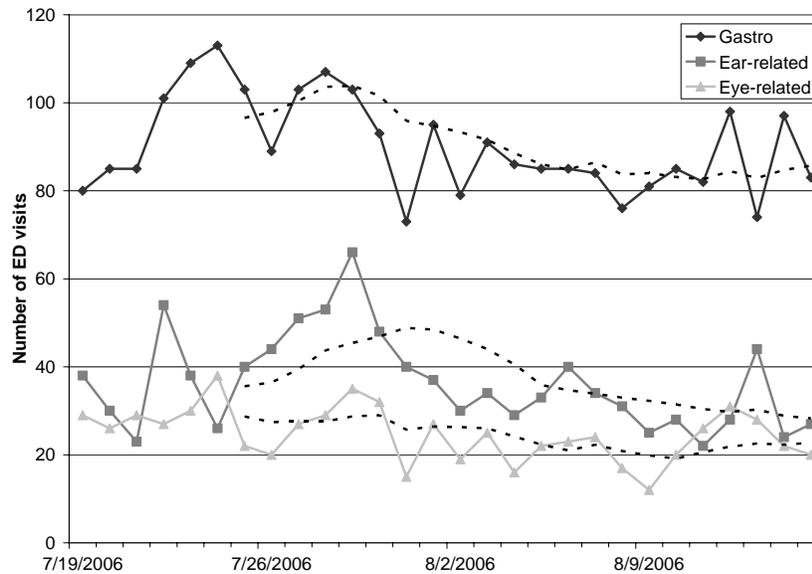
Figure 1. Daily Heat-Related ED Visits from 16 Hospital EDs in LAC, and Temperature Data from the Metro Area from June 1, 2006 to July 23, 2006, Overlaid by Seven-Day Moving Average Trend Lines



In order to estimate and track heat-related morbidity in LAC, the BT Unit monitored ED surveillance data from 16 hospitals in LAC to detect heat-related visits from June 1, 2006 to July 23, 2006. Patients with chief complaints containing key words such as: “heat exhaustion”, “dehydration”, “sun stroke”, “hyperthermia”, “overheat”, “heat rash”, and “feel hot” were classified as heat-related visits. Daily average temperatures for the LAC metro area were obtained from the website, weather.com and were analyzed for correlation with the number of heat-related ED visits. The ED data showed that the average number of heat-related visits per day substantially increased from 6.6 in June, to 8.3 in July ($p=0.04$). Daily heat-related ED visit counts were weakly correlated with temperature ($r=0.35$), although this may be in part because some heat-related ED visits may not have occurred on the day of exposure (Figure 1).

Health monitoring following raw sewage spill: On August 8, 2006, 20,000 to 30,000 gallons of raw sewage spilled near Ballona Creek and Marina Del Rey due to complications from a broken sewage line in Culver City, prompting the closure of two miles of beach [3]. While water tests indicated that bacteria returned to safe levels by August 10, 2006, beaches were not closed until 24 hours after the spillage ensued, exposing beachgoers to potentially high levels of bacteria. In response to this public health concern, syndromic surveillance was used to monitor increases in gastrointestinal, ear-related, or eye-related illnesses throughout LAC during this period, since these were the syndrome categories most likely to be experienced by those exposed to the sewage spill. Visits with chief complaints such as “otitis”, “ear pain”, and “ear ache” were classified into the ear-related category, while visits with chief complaints such as “conjunctivitis”, “eye pain”, “pink eye”, and “red eye” were classified as eye-related visits. Patients under two years of age were excluded.

Figure 2. Daily ED visits in 17 Syndromic Surveillance Participant ED Hospitals from July 19, 2006 to August 15, 2006. Historical Data (Data Prior to August 8, 2006) was Retrospectively Plotted for Baseline Comparison, along with Seven-Day Moving Average Trend Lines



There did not appear to be any increasing trend in ear-related, eye-related, or gastrointestinal ED visits subsequent to the sewage spill (Figure 2). Although it is possible that the syndromic surveillance was not sensitive enough to detect a change in ED visits resulting from the spill, the simplest explanation is that a substantial increase in morbidity did not occur. Given that the sewage was diluted once entering the ocean, and given that many viruses are unstable in an ocean environment, it was unlikely that many individuals would develop illnesses from their exposure, much less develop illnesses so severe as to necessitate visits to the ED. Corroborating evidence of this was provided by the LAC Environmental Health Division's Food and Milk Program, which interviewed 23 of 30 individuals who submitted foodborne illness reports during the days following the sewage spill. All denied visiting LAC beaches within three days prior to the onset of their illness.

Spinach outbreak: A widely publicized national *E. coli* outbreak related to spinach consumption resulted in 204 infected individuals in 26 states as of October 18, 2006, in which there were 102 hospitalizations and three fatalities [1,2]. Although the epidemiologic investigation concluded that contaminated spinach was not distributed within California, the BT Unit proceeded to conduct surveillance of any ED visits in LAC that were potentially related to the outbreak. Syndromic surveillance analyzed data from September 15, 2006 to December 11, 2006. The chief complaint and diagnosis fields were tagged if they contained the words "*E. coli*" or "Spinach" or the ICD-9 codes for *E. coli*. In all, the syndromic surveillance system detected 13 spinach outbreak-related ED visits in seven EDs. Of these, eight visits were reported in September, followed by two visits each in October and November, and only one visit in December. No additional suspect ED visits were subsequently found. All 13 patients were followed up by the ACDC foodborne unit, and none were diagnosed with *E. coli* infection. Eventually, only two residents of Shasta and Riverside counties in California were confirmed positive for the *E. coli* strain related to the outbreak [1,6].

DISCUSSION

While syndromic surveillance was initially developed for early detection of bioterrorism events, it has also been proven to be useful as an overall monitor of the public's health. No other system was or is now capable of providing a depiction of the public health impact of the 2006 summer heat wave, sewage spill,

and the multi-state *E. coli* outbreak on LAC residents; much less a temporal and spatial statistics-based assessment utilizing as much population-based data as was generated by the system, and in as near to real-time. Syndromic surveillance is also the only system capable of consistently generating and analyzing syndrome specific data without requiring additional steps for the hospital EDs once connected to the system. This may be especially important during a large-scale outbreak, for which classic methods of surveillance data collection (e.g., mandating the reporting of specific illnesses), may be time and resource expensive for both reporting medical providers and County epidemiologists who must manually tabulate incoming data.

Syndromic surveillance is not without its imperfections. Mild illnesses are difficult to capture, since they may not cause people to visit EDs. Other underlying medical conditions may cause symptoms similar to those of the illness of interest, and since only some hospital EDs transmit diagnosis data or provide a key that can be used to relocate patient records, it is currently impossible to completely eliminate misclassifications of syndrome categories. However, this should not affect the system's capability to assess changes in incidence, assuming that the same percentage of data is misclassified at any time when querying the same syndrome definition. For instance, assuming that the baseline number of heat-related ED visits established in June was applicable for July as well, syndromic surveillance was able to detect an increase in heat-related ED visits for the month, which corresponded with the increase in temperature. Syndromic surveillance also served in this capacity to provide assurances that the risks for potential outbreak events caused by the sewage spill and *E. coli* spinach contamination were stabilized.

Syndromic surveillance offers an easily configured and rapidly accessible population-based surveillance mechanism for illnesses that may otherwise not be rapidly quantifiable in LAC and surpasses other systems that cannot generate as much data as is collected and analyzed in as timely a manner to detect and monitor specific illnesses.

SaTScan™ is a trademark of Martin Kulldorff. The SaTScan™ software was developed under the joint auspices of (i) Martin Kulldorff, (ii) the National Cancer Institute, and (iii) Farzad Mostashari of the New York City Department of Health and Mental Hygiene.

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