USING SPATIAL SATSCAN™ STATISTICS IN SYNDROMIC SURVEILLANCE TO ENHANCE ILLNESS CLUSTER IDENTIFICATION

BACKGROUND

The Bioterrorism (BT) Surveillance Unit of the Los Angeles County (LAC) Department of Public Health, Acute Communicable Disease Control (ACDC) program conducts syndromic surveillance for early event detection and ongoing health events in near real-time. The syndromic surveillance system receives daily Emergency Department (ED) data representing over 40% of ED visits in LAC. These data are automatically classified into five major syndrome categories: gastrointestinal, neurological, rash, respiratory, and influenza-like illness. Syndrome-specific, ED-specific signals are generated when daily visits exceed thresholds determined by the Centers for Disease Control and Prevention (CDC)'s Early Aberration Reporting System (EARS) algorithm. In addition, SaTScan™ statistics are calculated using patient home zip codes to detect syndrome-specific spatial clusters. This report describes the utility of using both temporal and spatial analyses for assessing a rash signal and a neurological signal in 2006.

METHODS

Rash Signal: On October 10, 2006, syndromic surveillance detected a rash signal of six visits at one ED—two over the threshold (Figure 1). The small increase did not cause a substantial deviation in the total number of rash-related visits for all EDs. The line list, however, revealed that five of the patients resided in one zip code and synonymously cited chief complaints of "fever", "hair loss", and "rash." SaTScan™ analysis not only detected the rash cluster, but also served to emphasize that seeing five rash-related ED patients from this particular zip code on the specific date was extremely unusual (p=0.001) (Figure 2). Since the SaTScan™ cluster only included five rash patients, this implied that the sixth patient did not reside close enough to be included in the significant cluster. As also was insinuated by comparing chief complaints, this suggested that the sixth patient was probably an unrelated case.

The subsequent ACDC Hospital Outreach Unit (HOU) investigation revealed that all five patients were diagnosed with scabies and were from the same household, consisting of a father, mother, and three children. All were treated and discharged with thorough scabies education and instructions to receive follow-up care from a primary medical physician. It is unknown how the patients were originally infected, but some or all had been symptomatic for weeks before visiting the ED. Although there was potential for a scabies outbreak, syndromic surveillance did not detect any rash-related unusual activity in subsequent days. The case was closed the following day, when rash syndrome counts returned to temporally and spatially normal levels.

Figure 1. Rash Syndrome ED Visit Counts for All Participating EDs (top) and in the Specific ED that Generated a Signal (bottom), with 7-Day Moving Average Trend Lines (dashed)

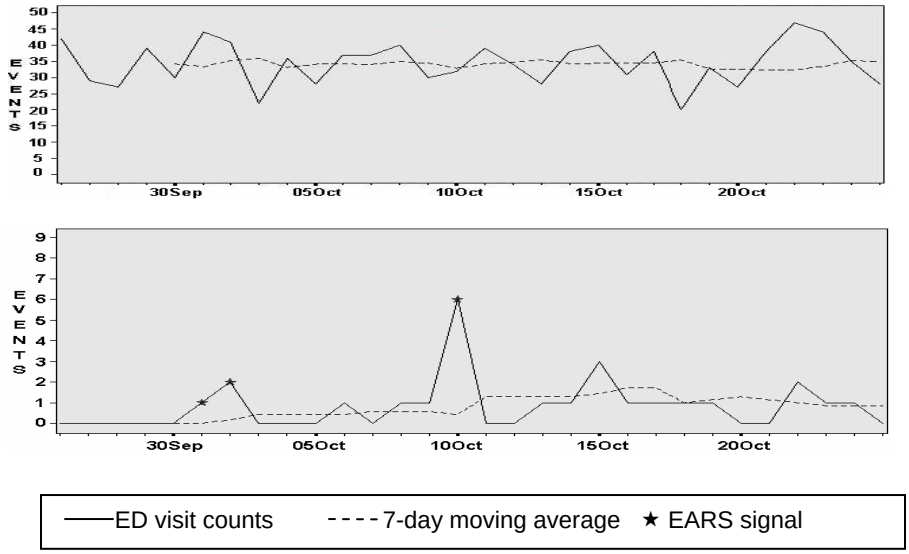
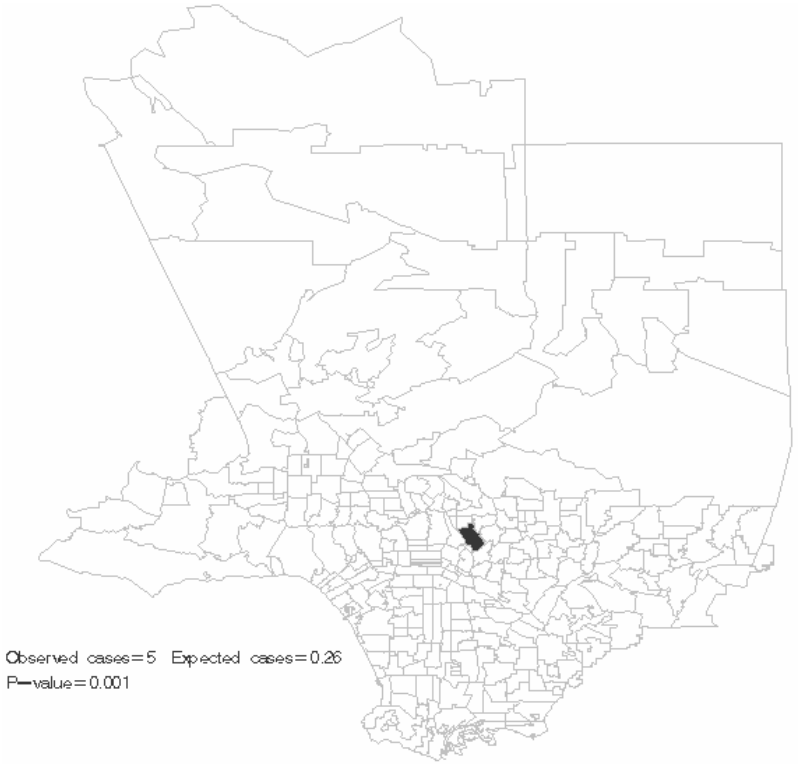
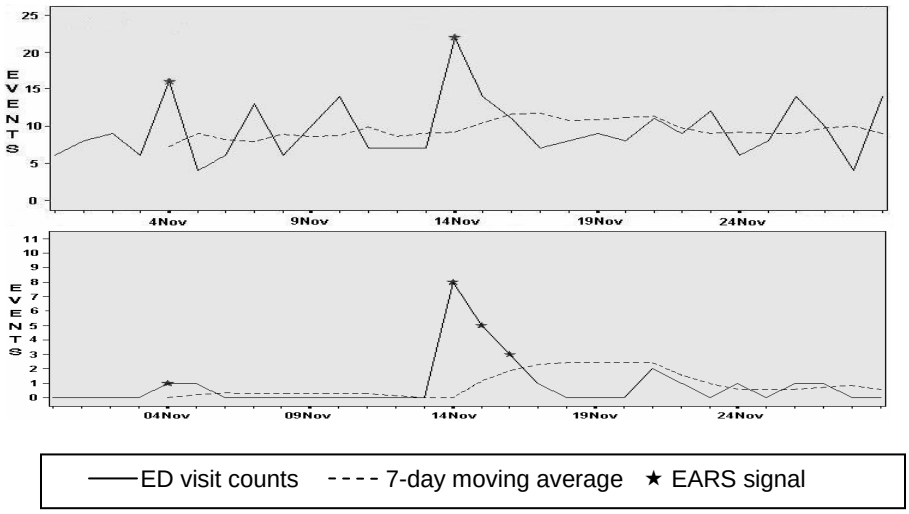


Figure 2. Map of Rash Syndrome Cluster of Patient Residence Zip Codes on October 10, 2006 for All Participating EDs



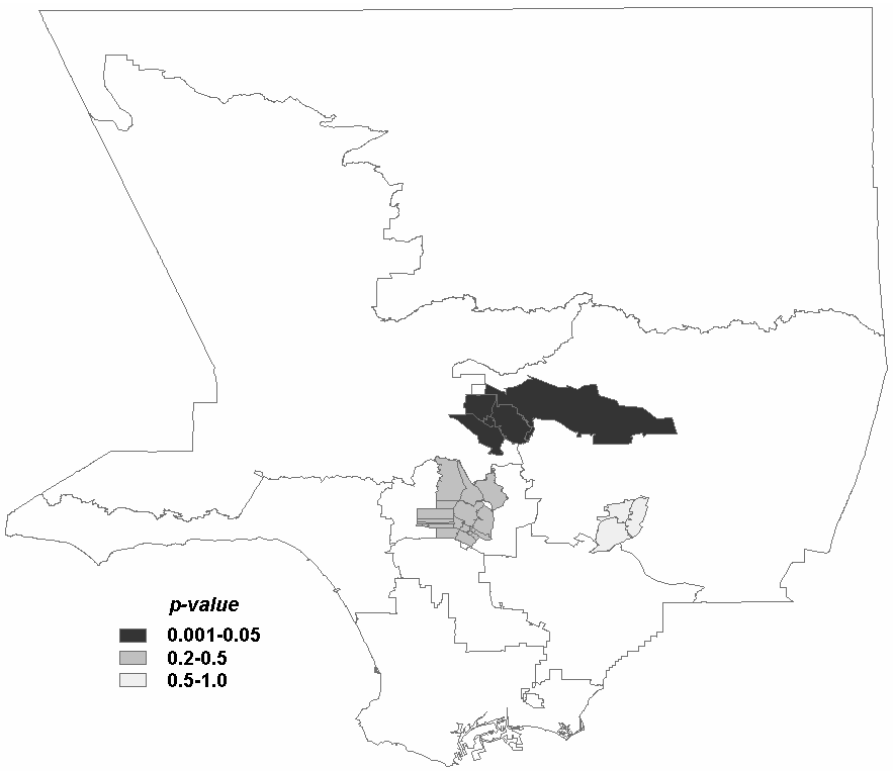
Neurological signal: On November 14, 2006, ACDC was alerted to a high school student who was symptomatic for meningitis. Syndromic surveillance subsequently detected five neurological syndrome visits over the threshold at one ED located in the vicinity of the high school (Figure 3). Unlike the scabies signal, this increase was large enough to cause a substantial aberration in the combined neurological syndrome counts across all EDs. Five of eight neurological syndrome patients were classified as meningitis-related due to having chief complaints which included “fever,” “headache,” or “meningitis.” Four patients cited “meningitis exposure.”

Figure 3. Neurological Syndrome ED Visit Counts for All Participating EDs (top) and in the ED Closest to the Event (bottom), with 7-Day Moving Average Trend Lines (dashed)



SaTScan™ also detected a substantial cluster of neurological syndrome patients from six adjacent zip codes in the vicinity of the high school on the same day (p=0.001) (Figure 4). Two additional neurological syndrome clusters were identified, albeit statistically weak (p≥0.2). Enhanced surveillance was thus expanded to neighboring EDs even if signals at those EDs were not detected. No additional meningitis-related visits were verified. Meanwhile, public health officials organized mass prophylaxis for all students potentially exposed to the index case. Eight more possibly meningitis-related visits to the same ED occurred over the next two days, of which five reported “meningitis exposure” and in some cases, specifically cited the high school in their chief complaint. The number of possible meningitis-related ED visits and SaTScan™ spatial statistics returned to normal on subsequent days, providing affirmation that a meningitis outbreak was successfully averted.

Figure 4. Map of Neurological Syndrome Cluster of Patient Residence Zip Codes on November 14, 2006 for All Participating EDs.



DISCUSSION

SaTScan™ is a tool for analyzing syndromic surveillance ED data that enhances ED-specific temporal (count-based) analysis. Since patient zip codes may not always correlate with which EDs were visited, SaTScan™ analysis may detect significant clustering in locations far from the hospital EDs at which temporal signals may be detected. It is also possible that SaTScan™ can detect substantial patient clusters when no ED-specific temporal signals are generated. This may occur if many people residing in an area become ill but choose to visit EDs in different locations.

Since SaTScan™ utilizes patient home zip code data, it may not be effective for detecting clusters if many zip code data are missing or if causative exposures took place far from home. However, when patient residence zip codes reflect the locations of their exposure, SaTScan™ may significantly improve the depiction of health events given by ED-specific temporal data alone. SaTScan™ not only corroborated the ED-specific rash signal, but also provided a quantitative basis with which the sixth rash patient could be excluded from the cluster. In the instance of the meningitis signal, SaTScan™ demonstrated its ability to help direct the locations to which surveillance should be expanded. Syndromic surveillance is thus amplified when SaTScan™ statistics are utilized in conjunction with ED-specific temporal signals to illustrate the spatial scope of health events and monitor subsequent days for secondary outbreaks.

SaTScan™ is a trademark of Martin Kulldorff. The SaTScanTM 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.