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POSTER ABSTRACTS

SECTION V: GENERAL POSTER PRESENTATIONS

Surveillance Systems for Bioterrorism Detection: a Systematic Review

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We sought to evaluate critically the evidence on the sensitivity, specificity, and timeliness of the existing surveillance systems for bioterrorism. We systematically searched for reports of potentially relevant surveillance systems in five databases of peer-reviewed articles (e.g., MEDLINE, 1985–2001) and Web sites of pertinent governmental and nongovernmental entities. We included reports if they described a system that could be used for the collection, analysis, or communication of surveillance data for bioterrorism-related diseases or syndromes. We reviewed 17,510 citations of peer-reviewed articles, 6,981 Web sites of government agencies, and 1,107 nongovernmental Web sites. From these, we included 115 systems that collect a variety of surveillance data: syndromic surveillance data (9 systems), influenza-related data (13 systems), clinicians' reports (6 systems), laboratory or antimicrobial data (23 systems), hospital-based infections (16 systems), foodborne illnesses (10 systems), zoonotic illnesses (6 systems), environmental detection systems (20 systems), and other types of surveillance data (12 systems). Only the 9 syndromic and 20 environmental detection systems were designed specifically for bioterrorism. Syndromic systems that collect a variety of surveillance data (e.g., clinicians' reports, *International Classification of Diseases, 9th Revision* [*ICD-9*] codes, and triage nurse incidence data) have been deployed for both event-based and continuous bioterrorism surveillance, and evaluations are ongoing. We conclude that few surveillance systems have been specifically designed for bioterrorism; however, numerous existing systems use methods of data collection, analysis, or reporting that are potentially relevant to bioterrorism surveillance. The current literature is largely descriptive, and additional studies are needed that comprehensively evaluate the sensitivity, specificity, and timeliness of these systems.

What's Wrong With Evaluating Syndromic Surveillance?

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The Centers for Disease Control and Prevention (CDC) guidelines for evaluating surveillance systems include examination of predictive value positive (PVP) and sensitivity. If incidence is zero, then quantitative evaluation results in a PVP of 0% (because the numerator is zero), and the value for sensitivity is indeterminate (because the denominator is zero). When incidence is above zero but extremely low, PVP will approach zero, and the predictive value negative (PVN) will approach 100% regardless of the test characteristics of sensitivity and specificity. For example, if incidence = 1 in 1 million, sensitivity = 100%, specificity = 99%, and 1 million events are screened, then the system will find the one event of interest, but PVP = 0.01% as there are 10,000 false positives (FPs) for every true positive (TP). Any re-

duction in specificity or incidence will reduce the PVP and raise the ratio of FP to TP; a reduction in sensitivity will also reduce the PVP. Efforts to improve the sensitivity and specificity of the screening method can increase PVP, but as long as incidence is low, the ratio of FP to TP will be high. There is a reticence to evaluate syndromic surveillance systems, which may be warranted. If the system has never experienced a TP, quantitative evaluation results are known in advance. There are three alternatives: process evaluation, evaluation of qualitative attributes, and simulations. The first two fail to assess how well the system finds cases of the target disease. The third may evoke the "Texas sharpshooter" fallacy: drawing the circle on the barn after shooting the rifle. If syndromic surveillance has value in detection of extremely rare events, evaluation remains a challenge.

Use of Simulated Bioterrorist Attacks to Evaluate Syndromic Surveillance Systems Based on Multiple Data Sources

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Syndromic surveillance systems are useful not only for early detection, but also for rapid monitoring of the spread of the outbreak. Syndromic surveillance systems based on single data sources have limited sensitivity, specificity, and predictive value. The aims of the current study were (1) to evaluate the contribution of multiple data sources to early detection and monitoring of unusual infectious disease outbreaks, (2) to evaluate LEADERS (Lightweight Epidemiology Advanced Detection and Emergency Response System) as a tool for syndromic surveillance systems, and (3) to evaluate dynamic changes in patterns of disease resulting from a simulated bioterror attack. Retrospective data on visits to community clinics and emergency rooms and reported deaths were used to generate mean and threshold incidence curves. The LEADERS platform was used for collection, storage, and analyses of data from different sources. A simulated anthrax outbreak based on the Svredlovsk outbreak was superimposed on background morbidity. GIS and SaTScan software (National Cancer Institute) were used for cluster analysis and the temporal-spatial changes in the different data sources were compared. A theoretical model demonstrates the progression from visits to outpatient clinics to admissions to emergency rooms to deaths. We conclude that differential dynamic changes in morbidity and mortality from different data sources are a useful means of detecting and monitoring unusual infectious disease outbreaks. More advanced statistical models will improve the performance of the system for early detection. A secured, Web-based system for integrating multiple data sources such as LEADERS will greatly facilitate the operation of the surveillance system.

Implementing the Centers for Disease Control and Prevention's Early Aberration Reporting System (EARS): a Frontline Perspective From the Knox County, Tennessee, Health Department

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This poster session demonstrates how the Early Aberration Reporting System (EARS), developed by the Centers for Disease Control and Prevention (CDC), was implemented at a local health department in Knox County, Tennessee, to serve as an early warning system for possible bioterrorism events. EARS is based on aberration detection models developed by CDC to identify deviations in current data when compared to a historical mean. The Knox County Health Department currently receives daily data from four sources: the 911 emergency call center, the Knox County public school system, a local hospital emergency department, and a local outpatient physician's group. Specific syndromes were selected from each of these data sources by the Knox County public health officer and the state epidemiologist. The EARS programs, which operate on an SAS software platform, analyze daily events for aberrations. When syndromes are flagged as aberrations, epidemiological staff review output and conduct further analyses, including the use of Geographic Information Series (GIS) to examine spatial clustering. If warranted, further investigation will be initiated. The EARS programs are easy to operate and adaptable to various data sources. Future goals for the Knox County system include automating electronic file transfer to ease the burden on data providers and improve the timeliness and quality of data. Due to the success of the EARS system in Knox County, the Tennessee Department of Health has targeted CDC's EARS as a model for statewide dissemination as part of the state Bioterrorism Preparedness Plan.

Application of Bioterrorism Surveillance Methods in San Diego County

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Strong surveillance infrastructure is critical for the ability of public health to detect and respond rapidly to a bioterrorism event. In 1999, San Diego County, California, developed the Enhanced Health Surveillance System, which includes various data sources, including prehospital chief complaints, foodborne illness complaints, medical examiner data, animal health data, and sentinel emergency department encounters. Also in 1999, San Diego developed the Emergency Medical Alert Network (EMAN), a bidirectional communications network that permits rapid notification of the medical community during emergencies and posts critical information to the EMAN Web site (www.emansandiego.com). San Diego is researching and applying aberration detection methodologies to syndromic data, including procedures to monitor large, nonrandom spikes (P Charts and U Charts) as well as small process shifts (exponentially weighted moving average [EWMA] and cumulative sum [CUSUM] charts). Intervention and response guidelines are in place to guide intervention and response efforts if aberrations are detected. Several events provided the opportunity to test the syndromic surveillance capabilities. During June 2001, San Diego hosted an international biotechnology convention. Syndromic surveillance was conducted using real-time prehospital chief complaint data, emergency department and urgent care encounters, and poison control data. After September 11, 2002, our early detection efforts detected a significant increase in prehospital transports for chest pain. Syndromic surveillance and aberration detection methodologies were to be expanded and refined during the Super Bowl. Plans exist to automate the systems, including data mining and the creation of decision models to improve timeliness and sensitivity. While systems may have been designed to detect acts of bioterrorism, they are proving invaluable for enhancing traditional surveillance efforts.

Using Autoregressive Epidemic Modeling to Augment the Existing Department of Defense (DoD) Febrile Respiratory Illness Surveillance System at Military Training Centers

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Military trainees have historically been susceptible to outbreaks of febrile respiratory illness (FRI). In the existing Department of Defense (DoD) FRI Surveillance System, a single, fixed epidemic threshold for FRI (1.5 cases/100 trainees/week) has been employed. Mathematical modeling has the potential to provide more sensitive alarm thresholds. Weekly FRI and population counts were recorded at four military training centers. Autoregressive modeling was used to generate expected case counts for the coming week and to set variable weekly alarm thresholds. A combination of variable and fixed alarm thresholds was used to detect FRI epidemics. Alarm status was updated each week as "green" (no epidemic), "yellow" (potential epidemic), or "red" (epidemic). At Fort Jackson, South Carolina, there were 34 (65%) green weeks, 7 (14%) yellow weeks, and 11 (21%) red weeks. The average FRI rates during green, yellow, and red weeks were 0.66, 0.81, and 1.21 cases per 100 trainees, respectively. Of the yellow weeks, 67% progressed to red status within 2 weeks. The current fixed alarm threshold was exceeded only two times during this period; both events were detected as red weeks by the experimental system. Similar results were seen at three other training centers. Autoregressive modeling identified epidemics detected by the current fixed threshold, as well as morbidity peaks below the fixed threshold. The system also correctly warned of approaching epidemics on several occasions. Adjusting the model to optimize sensitivity and specificity is under way. Variable alarm thresholds may be useful adjuncts to the traditional fixed alarm threshold for FRI at military basic training centers.

Development of an Alternative Surveillance Alert Program (ASAP): Syndromic Surveillance of Gastrointestinal Illness Using Pharmacy Over-the-Counter Sales

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A primary aim of community health surveillance is providing timely and accurate information on residents' health status and informing public health action. Presently, in Canada most notifiable infectious diseases are identified through laboratory confirmation. A significant period of time elapses when patients become ill, seek primary health care, and the eventual notification of public health officials. Should there be a severe and sudden introduction of an infectious agent in a community (unintentionally or as an intentional act of bioterrorism), this lag time is the biggest hindrance to implementing effective interventions to control the number becoming ill or even dying. In monitoring daily or weekly community-level pharmacy sales of over-the-counter (OTC) products related to gastrointestinal illness, statistically significant deviations in these sales from historical baselines could provide early warning of a potential outbreak situation. Retrospective case numbers and pharmacy OTC sales from two Canadian outbreaks related to *Cryptosporidium* (North Battleford, Saskatchewan) and *Escherichia coli* O157:H7 (Walkerton, Ontario) are presented in support of the potential for monitoring in this way. Health Canada has outlined a three-phase structure for piloting the implementation of an automated system. The first phase of this Alternative

Surveillance Alert Program (ASAP) involves collaborative activities with major retail pharmacy companies, automated data extraction, and appropriate statistical analyses of these aggregate data. Phase 2 will involve assessment of ASAP by selected public health units in different provinces. Ultimately, the vision is to create a nationwide, secure, Web-based monitoring system that could also have applications for other disease syndromes.

Evaluation of Potential Data Sources for Surveillance

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Multiple candidate syndromic surveillance data sources are compared to each other and to better-documented retrospective emergency room data collected by the state of Maryland to assess the value of the surveillance data in terms of timeliness, accuracy, and sensitivity for syndromes of interest. The data sources, including physicians' office visits, military treatment facility visits, over-the-counter medications, and school absentee data were collected in the National Capital Area over a 2-year period. Over this period, outbreaks of a variety of illnesses occurred, and these provide an opportunity to observe equivalent events in the different sources. Comparisons are made based on time series plots and correlations. Analysis methodologies include diagnosis filters, spatial filters, and time-dependent bias corrections.

The City of Baltimore's Multifaceted Bioterrorism Surveillance System

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In the aftermath of September 11, 2001, the Baltimore City Health Department (BCHD) in Maryland developed a multifaceted surveillance system, which was conceived by a partnership of private and public sectors and designed as an early warning system for the detection of bioterrorism. Information flows in from multiple sources to capture a strategic slice of life following the release of a biological or chemical agent of terror into the environment. Daily data input track the following syndromes: nonspecific respiratory infections, acute respiratory infections, febrile illness with flulike symptoms (with and without rash), unusual diarrhea, lymphadenopathy, septicemia, pneumonia, and death. Sources include selected outpatient clinics, all 11 emergency departments in the city, all emergency medical services prehospital calls, dog and cat carcasses collected by the Bureau of Animal Control, school absenteeism, and specific over-the-counter (OTC) medication sales from sentinel pharmacies. The collected information is processed and compiled by a database manager within BCHD and then analyzed by epidemiologists for trends and patterns. Aberrations are further analyzed, geographically mapped, and investigated. Standard reporting protocols and methodologies for analyses and interpretation have been developed to provide uniform data and consistent results. Daily reports are generated and disseminated to the commissioner of health, the mayor's office, state officials, the BCHD Bioterrorism Response Team, and contributing or partner institutions. These reports contribute to the understanding of the health care and related activities of the residents of Baltimore while functioning as an early warning system for biologic and chemical terrorism.

Integration of an Automated Reporting System in Infectious Disease Surveillance in Allegheny County, Pennsylvania

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The integration of computer-based surveillance (CBS) systems with routine health department surveillance activities can enhance the detection of and response to outbreaks or terrorist attacks. We reviewed lessons learned in implementation of electronic laboratory reporting (ELR) in Allegheny County, Pennsylvania, as a model to understand better the role of automated notifications. This CBS system comprises ELR, syndromic surveillance, and automated case detection. Since 1999, eight University of Pittsburgh Medical Center Health System microbiology laboratories have participated in automatic capturing of ELR data on diseases and conditions reportable to the Allegheny County Health Department (ACHD). Evidence from integrating ELR into public health surveillance activities in the Allegheny County Health Department highlights a need for increasing end-user involvement. A shared recognition of the threat of bioterrorism motivated hospitals to collaborate in the CBS initial implementation phase. Communication of research objectives to hospital and health department participants facilitated ELR piloting and validation. Piloting ELR without complete replacement of conventional reporting methods demonstrated its use in routine surveillance and increased its acceptance. By providing automated e-mail alerts of reportable positive tests and cultured organisms with significant antibiotic resistance patterns, ELR increased the timeliness of conventional reporting and assisted hospital infection control. Challenges discovered include uncertainty about the ability of ELR to replace conventional reporting methods, identification of optimal methods for automated outbreak detection, and maintenance of ongoing integration of ELR with laboratories and end users. Commitment to a collaborative approach with continual multilevel participation can enhance the successful development and usefulness of CBS.