Centers for Disease Control and Prevention
Epidemiology Program Office
Division of Public Health Surveillance and Informatics

Annotated Bibliography for Syndromic Surveillance

What is syndromic surveillance?
The term "syndromic surveillance" applies to surveillance using health-related data that precede diagnosis and signal a sufficient probability of a case or an outbreak to warrant further public health response. Though historically syndromic surveillance has been utilized to target investigation of potential cases, its utility for detecting outbreaks associated with bioterrorism is increasingly being explored by public health officials.

Purpose of this annotated bibliography
The purpose of this annotated bibliography is to provide an information resource addressing syndromic surveillance associated with bioterrorism. The primary audience is public health practitioners who want to learn more about syndromic surveillance methods or systems.

We attempted to gather key articles on syndromic surveillance associated with bioterrorism. Resources included in this bibliography are peer-reviewed articles, academic papers, technical reports, and Web-based information on syndromic surveillance systems. The resources are categorized by the following groupings: overview/general, analytic methods, informatics, evaluation of syndromic surveillance systems, and other resources. In addition, non-bioterrorism-related resources include information on syndromic surveillance not addressing bioterrorism that may still be of interest to readers.

Methods
Resources were derived from a variety of sources. First, a Pub Med search was conducted to find published peer-reviewed literature. The search strategy utilized the following key words in varying combinations: syndromic surveillance, bioterrorism, early detection outbreak, pre-diagnosis surveillance, non-traditional surveillance, enhanced surveillance, drop-in surveillance, health indicator surveillance, and disease early warning systems. Second, a search was conducted on Internet search engines (e.g., Google) to find non-peer-reviewed reports, (e.g., technical reports, abstracts, conference papers, etc.) and websites addressing syndromic surveillance. The type of resource is indicated after each citation for non-journal resources.

Limitations and Disclaimer

This bibliography is meant as an information-gathering resource on syndromic surveillance and systems for public health practitioners. The resources included have only been briefly summarized and are not intended to be an exhaustive bibliography. We will periodically update the bibliography with current and relevant resources. Finally, the inclusion of the names of any specific products or companies in this annotated bibliography does not constitute an endorsement by the Centers for Disease Control and Prevention.

A. Overview/General

1. Bioterrorism Preparedness and Response: Use of Information Technologies and Decision Support Systems. Summary, Evidence Report/Technology Assessment: Number 59, July 2002. Agency for Healthcare Research and Quality, Rockville, MD. (http://www.ahrq.gov/clinic/epcsums/bioitsum.htm)

   The Evidence Report details the methodology, results, and conclusions of a systematic and extensive search for published materials on the use of information technology and decision support systems to serve the information needs of clinicians and public health officials in the event of a bioterrorist attack. The information is intended to assist clinicians, public health officials, and policymakers to improve preparedness for a bioterrorism event.

2. Broome CV, Loonsk J. Public health information network – improving early detection by using a standards-based approach to connecting public health and clinical medicine. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 199-202. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

   This paper describes the Public Health Information Network (PHIN), particularly the functions and specifications that are relevant to early detection of disease outbreaks. The process of implementing systems that are compliant with PHIN is also described.

3. Buehler JW. Review of the 2003 National Syndromic Surveillance Conference – lessons learned and questions to be answered. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 18-22. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

   This paper provides a summary of the lessons learned from the 2003 National Conference on Syndromic Surveillance. Recommendations are also made for future steps in this developing field.

4. Buehler JW, Berkelman RL, Hartley DM, Peters CJ. Syndromic surveillance and bioterrorism-related epidemics. Emerging Infectious Diseases 2003 Oct; 9(10): 1197-1204. (http://www.cdc.gov/ncidod/eid/vol9no10/pdfs/03-0231.pdf)

   This paper provides an overview of the use of syndromic surveillance compared to clinicians' reports to yield a diagnosis in the event of a bioterrorist attack. Hypothetical factors that may influence the detection of epidemics attributable to specific CDC category A bioterrorism agents are also discussed.

Dembek ZF, Cochrane DG, Pavlin JA. Syndromic Surveillance: To the Editor. Emerging Infectious Diseases 2004 July; 10(7): 1333-1334. (http://www.cdc.gov/ncidod/eid/vol10no7/pdfs/03-1035_04-0125.pdf)

This letter to the editor provides comments on the article by Buehler et al, "Syndromic Surveillance and Bioterrorism-related Epidemics," and insight into the continuing discussion about the utility and role of syndromic surveillance.

Buehler JW, Berkelman RL, Hartley DM, Peters CJ. Syndromic Surveillance: In reply. Emerging Infectious Diseases 2004 July; 10(7): 1334-1335. (http://www.cdc.gov/ncidod/eid/vol10no7/pdfs/03-1035_04-0125.pdf)

The authors comment on several of the themes mentioned in the response to their article by Dembek et al.

5. Citarella BB, Mueller CJ, Tosh M. Disaster preparedness and home care: is there a connection? Caring 2004 Sept; 23(9): 18-21.

   This article describes the connection between home care and syndromic surveillance and how the work of home care professionals is a key component of early detection.

6. Duchin JS. Epidemiological Response to Syndromic Surveillance Signals. Journal of Urban Health 2003 80: i115-i116.

   This brief article describes a process of confirming and validating the syndromic surveillance signals before initiating a public health response.

7. Foldy SL. Linking better surveillance to better outcomes. In: Syndromic Surveillance : Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 12-17. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

   This paper presents a model of local public health work as a series of outcome driven processes. The report summarizes lessons learned from health emergencies in Milwaukee, Wisconsin to improve input, processing and linking surveillance to more efficient action.

8. Goodwin T, Noji E. Syndromic surveillance. European Journal of Emergency Medicine 2004 Feb; 11(1):1-2.

   Moore K. Real-time syndrome surveillance in Ontario, Canada: the potential use of emergency departments and Telehealth. European Journal of Emergency Medicine 2004 Feb; 11(1):3-11.

   The second paper reviews new bioterrorist and emerging infectious threats to public health in Ontario, Canada, and proposes a means of integrating a telephone-based health informatics service and emergency department triage with a first-line real-time 24-h a day syndrome surveillance system. The first article is a brief editorial on syndromic surveillance, which mentions the Moore article and questions whether the lessons learned regarding the efficacy of syndromic surveillance in the United States can be applied to the Canadian context.

9. Green MS, Kaufman Z. Surveillance for early detection and monitoring of infection disease outbreaks associated with bioterrorism. Israel Medical Association Journal 2002 Jul; 4(7): 503-6.

    This paper provides a brief overview of surveillance for bioterrorist initiated outbreaks and provides a few examples of syndromic surveillance systems, both internet and non-internet based surveillance information systems.

10. Henning KJ. Syndromic Surveillance. In Institute of Medicine 2003. Microbial Threats to Health: Emergence, Detection, and Response. Ed. Smolinski MS, Hamburg MA, Lederberg J. The National Academies Press, Washington, DC. 309-350. (http://www.iom.edu/report.asp?id=5381)

    This appendix chapter provides an overview of syndromic surveillance systems to enhance the detection of emerging infections and illness due to bioterrorism agents. The paper provides definitions and rationale, surveillance system attributes, types of syndromic surveillance systems, cost-effectiveness data if available and key steps in development of syndromic surveillance systems.

11. Henning KJ. What is syndromic surveillance? In: Syndromic Surveillance : Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 7-11. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

    This commentary provides a review of the rationale, goals, definitions, and realistic expectations for current syndromic surveillance systems. The author suggests that such a review is a critical step toward establishing a framework for further research and development.

12. Hopkins RS. Design and operation of state and local infectious disease surveillance systems. Journal of Public Health Management and Practice. 2005 May-Jun; 11(3): 184-190.

    This article describes options for the design and operation of infectious disease surveillance systems, including but not limited to syndromic surveillance systems. System parameters such as timeliness, sensitivity, and predictive value as well as issues related to content, sources of information, and incentives are discussed.

13. Koo D. Leveraging syndromic surveillance. Journal of Public Health Management and Practice. 2005 May-Jun; 11(3): 181-183.

    This editorial describes some of the critical surveillance methodologic issues that are exemplified by syndromic surveillance.

14. Lober WB, Karras BT, Wagner MM, Overhage JM, Davidson AJ, Fraser H, Trigg LJ, Mandl KD, Espino JU, Tsui FC. Roundtable on bioterrorism detection: information system-based surveillance. Journal of the American Medical Informatics Association 2002 Mar-Apr; 9(2): 105-15. (http://www.jamia.org/cgi/content/full/9/2/105)

    The Roundtable on Bioterrorism Detection was hosted during the 2001 AMIA annual Symposium, and its goal was to foster communication and cooperation about researchers in an effort to increase the pace of research and system deployment. This paper combines case reports of six existing systems with discussion of some common techniques and approaches for early detection of outbreaks.

15. Mandl KD, Overhage JM, Wagner MM, Lober WB, Sebastiani P, Mostashari F, Pavlin JA, Gesteland PH, Treadwell T, Koski E, Hutwagner L, Buckeridge DL, Aller RD, Grannis S. Implementing Syndromic Surveillance: A Practical Guide Informed by the Early Experience. Journal of the American Medical Informatics Association 2004; 11(2):141-150. (http://www.jamia.org/cgi/reprint/M1356v1.pdf)
    This article provides a comprehensive overview of syndromic surveillance methods and models. The authors stress the importance of surveillance system quality and the integration of syndromic surveillance with public health response. The article is intended to serve as a guide for informaticians, public health managers, and practitioners who may be planning deployment of such systems in their regions.

16. Mostashari F, Hartman J. Syndromic surveillance: a local perspective. Journal of Urban Health 2003; 80 Suppl 1:i1-i7.
    This paper provides a perspective on some of the key tensions and challenges facing the field of syndromic surveillance. Some of the issues include traditional versus nontraditional data sources, analytic approaches, evaluation, investigation of signals, security versus civil liberties, national versus local, and the dual use of these systems for bioterrorism and non-bioterrorism related research.

17. Muhm JM, Karras BT. Syndromic surveillance. Aviation, Space, and Environmental Medicine 2003 Mar;74 (3):293-4.
    This article briefly discusses the societal, technical, and analytical challenges of syndromic surveillance.

18. Pavlin JA. Investigation of Disease Outbreaks Detected by "Syndromic" Surveillance Systems. Journal of Urban Health 2003; 80: i107-i114.
    This article describes the steps of disease outbreak investigation to syndromic surveillance signals: confirm existence of outbreak, verify diagnosis, estimate the number of cases, orient to person, place, and time, develop and evaluate hypothesis, implement control measures, and communicate findings. Examples of outbreaks detected by an electronic surveillance system are described.

19. Platt R, Bocchino C, Caldwell B, Harmon R, Kleinman K, Lazarus R, Nelson A, Nordin JD, Ritzwoller. Syndromic surveillance using minimum transfer of identifiable data: the example of the National Bioterrorism Syndromic Surveillance Demonstration Program. Journal of Urban Health 2003; 80 Suppl 1:I25-I31.
    This paper presents a brief description of a surveillance system that relies principally on reporting by health plans to public health agencies of aggregated (count) data, rather than on reporting of encounter-level data, and it discusses the reasons for adopting this method of data-sharing for syndromic surveillance.

20. Reingold A. If syndromic surveillance is the answer, what is the question? Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science 2003; 1(2): 1-5.
    This policy paper analyzes some of the underlying assumptions put forward in support of syndromic surveillance, and the author urges closer scrutiny of these assumptions before

investing scarce public health resources. Assumptions include: reducing morbidity/mortality following a bioterrorist attack; types of bioterrorists events detected; responding to increases signaled by syndromic surveillance, increased timely identification of population at risk; providing useful information about naturally occurring infectious disease, and strengthening local and state health departments.

21. Sosin DM. Syndromic surveillance: The case for skillful investment. Biosecurity and Bioterrorism: Biodefense Strategy, Practice and Science 2003 1(4): 247-253.
    This article presents an overview of syndromic surveillance and emphasizes the need to determine if its additional contribution to bioterrorism preparedness is worth the cost. The author discusses important research needs that would help establish the value of syndromic surveillance for early outbreak detection when compared with other public health investments. (http://www.syndromic.org/pdf/pubs/2003_BIOSECURITY-Syndromic_Investment-Sosin.pdf)

22. Syndromic surveillance. Healthcare Hazard Management Monitor. 2003 Apr;16(8):1-6.
    This article provides an overview of syndromic surveillance, as compared to traditional public health surveillance, discussing healthcare involvements, challenges and limitations of syndromic surveillance.

23. Teich JM, Wagner MM, Mackenzie CF, Schafer KO. The informatics response in disaster, terrorism, and war. Journal of the American Medical Informatics Association 2002 Mar-Apr; 9(2): 97-104. (http://www.jamia.org/cgi/content/full/9/2/97)
    The paper presents an overview of bioterrorism, mass disasters, and remote military operations and discusses the ongoing work of experts who began working on these problems before the current national crisis. Included in the bioterrorism section is a discussion of the need for real time surveillance and examples of early warning systems for outbreak detection.

24. Wagner MM, Tsui FC, Espino JU, Dato VM, Sittig DF, Caruana RA, McGinnis LF, Deerfield DW, Druzdzel MJ, Fridsma DB. The emerging science of very early detection of disease outbreaks. Journal of Public Health Management Practice 2001 Nov; 7(6): 51-9.
    The authors identify and review mathematical foundations of early detection and review the literature on defining timeliness requirements for specific threats and on measuring the timeliness of specific detection systems for specific threats.

25. Zeng X, Wagner M. Modeling the effects of epidemics on routinely collected data. Journal of the American Medical Informatics Association. Proceedings AMIA Symposium 2001;:781-5. (http://www.jamia.org/cgi/reprint/9/6_suppl_1/S17.pdf)
    The authors reviewed studies in behavioral medicine and health psychology in order to build a model linking known factors related to human health information and treatment seeking behavior and effects on routinely collected data (e.g., absenteeism). A model of patient behavior after a bioterrorism attack is provided.

B. Analytic Methods

- **Data Sources and Case Definition**

1. Barthell EN, Aronsky D, Cochrane DG, Cable G, Stair T. The Frontlines of Medicine Project progress report: standardized communication of emergency department triage data for syndromic surveillance. Annals of Emergency Medicine 2004 Sept; 44 (3): 247-252.
   This article reports the progress of the Frontlines Medicine Project, a collaborative effort to develop nonproprietary, standardized methods of reporting emergency department patient data. The article reviews the outcome of the project meeting in April 2002, and describes the Delphi Survey process to define data elements in a triage surveillance report and to define a set of codified values for the chief complaint data element.

2. Begier EM, Sockwell D, Branch LM, Davies-Cole JO, Jones LH, Edwards L, Casani JA, Blythe D. The National Capitol Region's emergency department syndromic surveillance system: do chief complaint and discharge diagnosis yield different results? Emerging Infectious Diseases 2003 Mar; 9(3): 393-6. (http://www.cdc.gov/ncidod/EID/vol9no3/pdfs/02-0363.pdf)
   The paper compared syndromic categorization of chief complaint and discharge diagnosis for 3,919 emergency department visits to two hospitals in the U.S. National Capitol Region. The result showed that agreement between chief complaint and discharge diagnosis was good overall, but substantial variability existed by syndrome.

3. Beitel AJ, Olson KL, Reis BY, Mandl KD. Use of emergency department chief complaint and diagnostic codes for identifying respiratory illness in a pediatric population. Pediatric Emergency Care 2004 Jun; 20(6): 355-360.
   The authors of this article describe the value of emergency department chief complaint (CC) and International Classification of Disease diagnostic codes for identifying respiratory illness in a pediatric population. They also suggest that syndromic surveillance systems could be made more efficient by improving the accuracy of emergency department CC data.

4. Chapman WW, Christensen LM, Wagner MM, Haug PJ, Ivanov O, Dowling JN, Olszewski RT. Classifying free-text triage chief complaints into syndromic categories with natural language processing. Artificial Intelligence in Medicine. 2005; 33: 1-10.
   This article describes the use and evaluation of a natural language processing text classifier (used by the Real-time Outbreak and Disease Surveillance System) to classify free-text triage chief complaints into syndromic categories. The authors found that the text classifier could accurately extract data from free-text chief complaints for use in biosurveillance.

5. Chen JH, Schmit K, *et al*. Use of Medicaid prescription data for syndromic surveillance—New York. MMWR Morb Mortal Wkly Rep. 2005 Aug 26; 54 Suppl: 31-4. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a7.htm)
   This report examines the usefulness of Medicaid prescription data for statewide syndromic surveillance in New York State. Daily Medicaid claims were transmitted as

summary counts by zip code, age, sex, and 18 medication groups. The data was analyzed by the CUSUM statistic. A pertussis induced antibiotic increase was flagged in the system.

6. Cochrane DG. Perspective of an emergency physician group as a data provider for syndromic surveillance. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 209-214. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
   This paper describes the motivations and concerns of the Emergency Medical Associates of New Jersey, an emergency medicine group, as a data provider. The paper also discusses the opportunities for collaboration between the public health and emergency medicine communities, how data from electronic medical records have been used for research in syndromic surveillance, and how these data might be used to enhance real-time surveillance

7. Day FC, Schriger DL, La M. Automated linking of free-text complaints to reason-for-visit categories and *International Classification of Diseases* diagnoses in emergency department patient record databases. Annals of Emergency Medicine 2004 Mar; 43(3): 401-409.
   This study addressed whether information obtained early in an emergency department (ED) visit, such as plain-text chief complaint data, could quickly be processed to assign a reason-for-visit category. A prospective, reason-for-visit-based ED classification system could have several useful applications including syndromic surveillance.

8. Espino, J.U., Wagner, M.M. Accuracy of ICD-9-coded chief complaints and diagnoses for the detection of acute respiratory illness. Proceedings AMIA Symposium 2001;164-8. (http://rods.health.pitt.edu/LIBRARY/amia2001_final_reviedEspino.pdf)
   This study validates two detectors for acute respiratory illness, ICD-9-coded chief complaints and ICD-9-coded diagnoses, against the human classification of cases based on review of emergency department reports from the electronic medical record system. Using ICD-9-coded chief complaints, the sensitivity of detection of acute respiratory illness was 0.44 and its specificity was 0.97. The sensitivity and specificity using ICD-9-coded diagnoses were no different.

9. Fienberg SE, Shmueli G. Statistical issues and challenges associated with rapid detection of bio-terrorist attacks. Statistics in Medicine. 2005; 24: 513-529.
   This paper explores different sources of data that can be used for the early detection of outbreaks and focuses on the statistical issues and challenges associated with non-traditional data sources and the integration of multiple data sources for timely detection.

10. Goldenberg A, Shmueli G, Caruana RA, Fienberg SE. Early statistical detection of anthrax outbreaks by tracking over-the-counter medication sales. Proceedings of the National Academy of Sciences of the United States of America 2002 Apr 16; 99(8): 5237-5240.
   This paper describes a statistical framework for monitoring grocery data to detect a large-scale but localized bioterrorism attack, and it also proposes an evaluation methodology that is suitable in the absence of data on large-scale bioterrorist attacks and disease outbreaks.

11. Greenko J, Mostashari F, Fine A, Layton M. Clinical Evaluation of the Emergency Medical Services (EMS) Ambulance Dispatch-Based Syndromic Surveillance System, New York City. Journal of Urban Health. 2003 Jun;80 Suppl 1:I50-I56.
    This paper describes a system that uses Emergency Medical Services (EMS) ambulance dispatch data to monitor for a communitywide rise in influenza-like illness (ILI) as an early detection system for bioterrorism, and it examines the potential bias involved in EMS data versus emergency department-based surveillance for ILI and determines the case sensitivity and predictive value positive of the selected EMS call types for ILI.

12. Hirshon JM. The rationale for developing public health surveillance systems based on emergency department data. Academic Emergency Medicine. 2000 Dec;7(12):1428-32.
    This article describes current concepts and status of emergency department surveillance systems, their advantages and disadvantages, the rationale for their existence, and recommendations to allow their continued consideration and development.

13. Ivanov O, Wagner MM, Chapman WW, Olszewski RT. Accuracy of three classifiers of acute gastrointestinal syndrome for syndromic surveillance. Proceedings AMIA Symposium 2002;:345-9.
    This study validates three classifiers for the detection of cases of acute gastrointestinal syndrome (one used ICD-9-coded emergency department diagnosis as input data; the other two used free-text triage diagnosis) against the expert classification of cases based on review of emergency department reports. The study concluded that the naïve Bayes classifier of free-text triage diagnosis data provides more sensitive and earlier detection of cases than either the bigram Bayes classifier or an ICD-9 code classifier.

14. Jones NF, Marshall R. Evaluation of an electronic general-practitioner-based syndromic surveillance system – Auckland, New Zealand, 2000-2001. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 173-178. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This paper summarizes the evaluation of the general-practitioner-based syndromic surveillance system (GPSURV) piloted by the Aukland Regional Public Health Service from 2000 to 2001. The evaluation assessed data capture, the method used to distinguish initial from follow-up visits, the definition of denominators, and the external validity of measured influenza-like illness trends.

15. Magruder SF, Lewis SH, Najmi A, Florio E. Progress in understanding and using over-the-counter pharmaceuticals for syndromic surveillance. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 117-122. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This report provides new information about the timeliness and lead time of using over-the-counter (OTC) product data for syndromic surveillance. The paper also describes a method for aggregating OTC data using the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE II).

16. Mikosz CA, Silva J, Black S, Gibbs G, Cardenas I. Comparison of two major emergency department-based free-text chief-complaint coding systems. In: Syndromic Surveillance:

Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 101-105. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

This study compared the New York City Department of Health and Mental Hygiene syndrome coding system and the Real-Time outbreak Detection System Complaint Coder for agreement between free-text interpretation and syndrome coding. The authors concluded that although there was agreement between the two major ED-based free-text chief-complaint coding systems, there is still a need for a consensus regarding chief complaint classification.

17. Pavlin JA, Mostashari F, Kortepter MG, Hynes NA, Chotani RA, Milkol YB, Ryan M, Neville JS, Gantz DT, Writer JV, Florance JE, Culpepper RC, Henretig FM, Kelley PW. Innovative surveillance methods for rapid detection of disease outbreaks and bioterrorism: results of an interagency workshop on health indicator surveillance. American Journal of Public Health. 2003 Aug; 93(8): 1230-1235.

    This paper provides a summary of the findings from a workshop sponsored by the Department of Defense Global and Emerging Infections System in May 2000. Expectations and recommendations for new surveillance systems are discussed including the need for a nationally led effort in developing health indicator surveillance methods to promote effective, innovative systems.

18. Pavlin JA, Murdock P, Elbert E, Milliken C, Hakre S, Mansfield J, Hoge C. Conducting population behavioral health surveillance by using automated diagnostic and pharmacy data systems. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 166-172. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

    This paper describes population-based behavioral health surveillance conducted among military-health-system beneficiaries. The study analyzed the effectiveness of using prescribing patterns of psychotropic medications to monitor behavioral health trends in changes in a population.

19. Reis BY, Mandl KD. Syndromic surveillance: the effects of syndrome grouping on model accuracy and outbreak detection. Annals of Emergency Medicine 2004 Sept; 44 (3): 235-241.

    This study aims to measure the impact of three syndromic grouping methods: chief complaints, *International Classification of Diseases, Ninth Revision* (ICD-9) diagnostic codes and an inclusive combination of chief complaints and ICD-9 codes, on model accuracy and detection sensitivity. The authors conclude that better surveillance can be achieved when proper syndromic groupings are applied to certain types of data.

20. Shapiro AR. Taming variability in free text: application to health surveillance. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 95-100. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

    This paper describes the problem of word variation in chief-complaint data and explores three semi-automated approaches for addressing it. The authors conclude that the text normalization methods described in this paper can reduce the effects of incomplete vocabulary and word errors that can have an impact on the retrieval performance of free-text syndromic systems.

21. Townes JM, Kohn MA, Southwick KL, Bangs CA, Zechnich AD, Magnuson JA, Jui J. Investigation of an electronic emergency department information system as a data source for respiratory syndrome surveillance. Journal of Public Health Management and Practice 2004 Jul-Aug; 10(4): 299-307.
    This study explores how an electronic emergency department information system (EDIS), currently in use at Oregon Health and Sciences University, might be used as a source for respiratory syndromic surveillance. The investigation concluded that potentially useful data can be automatically extracted from an existing EDIS and be transmitted to a health department for syndromic surveillance purposes.

22. Tsui F, Wagner M, Dato V, Chang C. Value of ICD-9-Coded Chief Complaints for Detection of Epidemics. Proceedings AMIA Symposium 2001;:711-5. (http://rods.health.pitt.edu/LIBRARY/AMIA2001Tsui.pdf)
    This study assesses the value of ICD-9-coded chief complaints for early detection of epidemics, the sensitivity, positive predictive value, and timeliness of Influenza detection using a respiratory set and Influenza set of ICD-9 codes.

23. Wagner MM, Aryel R, Dato VM, Krenzelok E, Fapohunda A, Sharma R. Availability and Comparative Value of Data Elements Required for an Effective Bioterrorism Detection System. 184 pages. Report commissioned by AHRQ. Delivered November 28, 2001 (Awaiting Publication). (http://rods.health.pitt.edu/LIBRARY/dato2AHRQInterimRpt112801.pdf)
    This report, commissioned by the Agency for Healthcare Research and Quality, addresses three related questions: (1) What data elements are required for an effective bioterrorism detection system; (2) What are their comparative values; and (3) What are their availability?

- **Analytic Modeling and Event Detection**

1. Buckeridge DL, Burkom H, Moore A, Pavlin J, Cutchis P, Hogan W. Evaluation of syndromic surveillance systems – design of an epidemic simulation model. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 137-143. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This paper describes the design for a simulation model to allow the evaluation of the outbreak-detection characteristics of a syndromic surveillance system. In particular, the objective of the analysis of a simulated anthrax epidemic injection model that accounted for background data and enabled sensitivity analysis based on uncertain disease-agent characteristics was discussed.

2. Buckeridge DL, Graham JK, O'Connor MJ, Choy MK, Tu SW, Musen MA. Knowledge-based bioterrorism surveillance. Proceedings AMIA Symposium 2002;:76-80. (http://smi-web.stanford.edu/projects/biostorm/bibliography/BuckeridgeAMIA2002.pdf)

This paper presents an argument for knowledge-based surveillance, describes a prototype of BioSTORM, a system for real-time epidemic surveillance, and shows an initial evaluation of this system applied to a simulated epidemic from a bioterrorism attack.

3. Burkom HS. Biosurveillance applying scan statistics with multiple, disparate data sources. Journal of Urban Health. 2003 Jun;80 Suppl 1:I57-I65.
   This paper describes the application of scan statistics for early outbreak detection in Essence II, and extension of Essence I. Information was combined from disparate medical sources, including number of emergency room visits, outpatient visits, and insurance claims, and from non-medical sources such as counts of OTC remedy sales and school absenteeism.

4. Burkom HS, Elbert Y, Feldman A, Lin J. Role of data aggregation in biosurveillance detection strategies with applications from ESSENCE. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 67- 73. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
   This paper discusses the application of spatial and temporal data-aggregation strategies, the relevance of data aggregation to the effectiveness of alerting algorithms and the approaches used by the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE). An evaluation exercise of these approaches conducted in 2003 by the Bio-Event Advanced leading Indicator Recognition Technology (Bio-ALIRT) program of the Defense Advanced research project Agency (DARPA) is also discussed.

5. Dafni UG, Tsiodras S, Panagiotakos D, Gkolfinopoulou K, Kouvatseas G, Tsourti Z, Saroglou G. Algorithm for statistical detection of peaks – syndromic surveillance system for the Athens 2004 Olympic Games. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 86-94. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
   This paper proposes an algorithm for statistical detection of peaks and evaluates the usefulness of the Pulsar approach, which is based on removing long term trends from the series of observations and identifying peaks in the residual series of data. Alerts are generated by taking both height and breadth of signals and the proposed method was applied in the Athens Olympic syndromic surveillance system database.

6. Hanslik T, Boelle PY, Flahault A. The control chart: an epidemiological tool for public health monitoring. Public Health 2001; 115: 227-281.
   This paper describes a pilot study that was conducted during the 1998 World Football Cup and applied statistical process control charts to short term intense public health surveillance based on outpatient physician visits. The control charts, graphic tools used to determine whether a process remains within an acceptable range of variation, provided public health authorities with an early warning system.

7. Hutwagner LC, Thompson WW, Seeman GM, Treadwell T. A simulation model for assessing aberration detection methods used in public health surveillance for systems with limited baselines. Statistics in Medicine. 2005; 24:543-550.

This paper evaluates three limited baseline cumulative sum (CUSUM) aberration detection methods, using simulated data from enhanced syndromic surveillance systems. The three methods are compared regarding their sensitivity, specificity, and predictive value. These methods are part of the Centers for Disease Control and Prevention (CDC) early aberration reporting system (EARS) and have been used to carry out enhanced surveillance for bioterrorism associated events.

8. Hutwagner L, Thompson W, Seeman GM, Treadwell T. The Bioterrorism Preparedness and Response Early Aberration Reporting System (EARS). Journal of Urban Health. 2003 Jun 1;80 Supplement 1:I89-I96.
   This paper describes the CDC Early Aberration Reporting System which allows the analysis of the public health surveillance data using available aberration detection methods. The primary purpose of EARS is to provide national, state, and local health departments with several alternative aberration detection methods for epidemiologic investigations.

9. Kleinman KP, Abrams AM, Kulldorff M, Platt R. A model-adjusted space-time scan statistic with an application to syndromic surveillance. Epidemiology and Infection 2005; 133: 409-419.
   This article describes a model-based method for adjusting the space-time scan statistic in order to account for naturally occurring temporal and spatial patterns of illness. Results indicate that temporal and spatial adjustments are needed when using the space-time scan statistic for syndromic surveillance.

10. Kleinman KP, Abrams A, *et al*. Simulations for assessing statistical methods of biologic terrorism surveillance. MMWR Morb Mortal Wkly Rep. 2005 Aug 26; 54 Suppl: 101-8. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a17.htm)
    This report describes conceptual features of an anthrax dispersal simulation and used the simulated data to evaluate algorithms for their effectiveness in early detection of a bioterrorism attack.

11. Kleinman K, Lazarus R, Platt R. A generalized linear mixed models approach for detecting incident clusters of disease in small areas, with an application to biological terrorism. American Journal of Epidemiology 2004 Feb 1; 159(3): 217-224. (http://www.syndromic.org/pdf/pubs/2004-GLMM%20Approach-Kleinman.pdf)

    Waller LA. Invited commentary: Surveilling surveillance- some statistical commentary. American Journal of Epidemiology 2004 Feb 1; 159(3): 225-227. (http://www.syndromic.org/pdf/pubs/2004-GLMM%20Approach%20Commentary-Waller.pdf)

    Kleinman K, Lazarus R, Platt R. Kleinman et al. respond to "Surveilling surveillance." American Journal of Epidemiology 2004 Feb 1; 159(3): 228. (http://www.syndromic.org/pdf/pubs/2004-GLMM%20Approach%20Commentary%20Reply-Kleinman.pdf)

The first article proposes an approach using generalized linear models to evaluate whether observed counts in initial symptoms of disease are larger than would be expected on the basis of a history of naturally occurring diseases. The approach is illustrated using data on health-care visits from a large Massachusetts managed care organization/multi-specialty practice group in the context of syndromic surveillance for anthrax. The second and third articles provide remarks on the first article and the authors' response to this commentary, respectively.

12. Koch MW, McKenna SA. Near-real time surveillance against bioterror attack using space-time clustering 2001. [Accessed March 1, 2003]. (Technical Report) (http://www.prod.sandia.gov/cgi-bin/techlib/access-control.pl/2001/010820p.pdf)
    The technical report discusses the use of space-time clustering to detect bioterror attacks, and illustrate its use of detecting a flu epidemic with data collected by the French Sentinel Disease Network. Plans to extend space-time clustering to data collected for the Rapid Syndrome eValuation Project (RSVP) are also discussed.

13. Kulldorff M, Heffernan R, Hartman J, Assuncao R, Mostashari F. A space-time permutation scan statistic for disease outbreak detection. PLoS Medicine 2005 March; 2(3): 216-224. (http://medicine.plosjournals.org/archive/1549-1676/2/3/pdf/10.1371_journal.pmed.0020059-S.pdf)
    This paper proposes a space-time permutation scan statistic that uses only case data for the early detection of disease outbreaks. This new method for prospective infectious disease outbreak surveillance was evaluated using daily analyses of hospital emergency department visits in New York City and could be an important tool for health departments that are setting up syndromic surveillance systems.

14. McKenna SA. Development of a discrete spatial-temporal SEIR simulator for modeling infectious diseases. November 2000. [Accessed April 11, 2003]. (Technical Report) (http://www.prod.sandia.gov/cgi-bin/techlib/access-control.pl/2000/002232.pdf)
    This technical report examines the application of the SEIR model, which describes four discrete states of an epidemic (susceptible, exposed, infectious, and Recovered), to the spatial and temporal evolution of disease.

15. Miller B, Kassenborg H, Dunsmuir W, Griffith J, Hadidi M, Nordin J, Danila R. Syndromic surveillance for influenzalike illness in an Ambulatory Care Network. Emerging Infectious Diseases 2004 Oct; 10(10): 1806-1811. (http://www.cdc.gov/ncidod/EID/vol10no10/pdfs/03-0789.pdf)
    This article describes the development, and implementation of a time-series autoregressive and cumulative sum (CUSUM)-based detection algorithm. Using data from a large health maintenance organization in Minnesota, the authors evaluate the algorithm's ability to detect increases of influenza-like illness (ILI).

16. Moore A, Cooper G, Tsui R, Wagner M. Summary of Biosurveillance-relevant statistical and data mining technologies. [Accessed January 20, 2006] (Internet Report) (http://www.autonlab.org/autonweb/14638/version/2/part/5/data/moore-biosurv.pdf?branch=main&language=en).

A short Internet report compiling the technologies used for biosurveillance by the Center for Biomedical Informatics, University of Pittsburgh. It indicates which analytic methods have been implemented and evaluated in different settings and the reasons they were selected for use in some situations.

17. Musen MA, O'Connor MJ, Buckeridge DL, Graham J, Noy NF, Shahar Y, Henry KA. A knowledge-based approach to temporal abstraction of clinical data for disease surveillance. [Accessed April 11, 2003]. (Internet Report) (http://smi-web.stanford.edu/auslese/smi-web/reports/SMI-2001-0891.pdf)

    This paper describes an automated method, known as the knowledge-based temporal abstraction method, for analysis of electronic patient-record data that uses medical knowledge to infer high-level patterns from primary data.

18. Najmi AH, Magruder SF. Estimation of hospital emergency room data using otc pharmaceutical sales and least mean squares filters. BMC Medical Informatics and Decision Making 2004; 4: 5.

    The purpose of this article is to present evidence that when grouped appropriately, over the counter (OTC) data show time-dependent correlations with clinical data. The authors demonstrate that Finite Impulse Response (FIR) least squares filtering is a viable means of estimating acute respiratory condition from OTC sales, and provides quantitative measures of time dependent correlations between the clinical data and the OTC data channels.

19. O'Brien SJ, Christie P. Do CuSums have a role in routine communicable disease surveillance? Public Health 1997 Jul; 111(4):255-8.

    This paper describes the CuSum technique, which allows rapid measurement of change from expected values based on historical data. CuSums represent a potentially useful adjunct to other surveillance methods in infection control.

20. Ozonoff A, Forsberg L, Bonetti M, Pagano M. Bivariate method for spatio-temporal syndromic surveillance. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 61-66. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

    This report proposes a bivariate method that uses both temporal and spatial data information and illustrates this method using upper respiratory syndromic data from a major health-care provider in eastern Massachusetts. The power to detect simulated clusters is also discussed and the authors conclude that syndromic surveillance systems should use all available information including both spatial and temporal data.

21. Reis BY, Mandl KD. Integrating syndromic surveillance data across multiple locations: effects on outbreak detection performance. Proc AMIA Symp. 2003;: 549-553. (http://www.amia.org/pubs/proceedings/symposia/2003/112.pdf)

    This article addresses how different methods of data integration affect outbreak detection. Three models were constructed: two based on the daily visit totals for two different hospitals respectively and one based on the combined daily visit totals. The study found

that there were complementary benefits from both local and aggregate approaches and recommends a hybrid approach that maintains both localized and aggregate models.

22. Reis BY, Mandl KD. Time series modeling for syndromic surveillance. BMC Medical Informatics and Decision Making 2003 Jan 23; 3(1): 2. (http://www.biomedcentral.com/1472-6947/3/2)

    Using time-series methods, the authors developed and tested robust models of emergency department utilization for the purpose of defining expected visit rates as well as the frequency of visits of patients with flu-like and respiratory illnesses. The models were based on nearly a decade of historical data at a major metropolitan academic, tertiary care pediatric emergency department.

23. Reis BY, Pagano M, Mandl KD. Using temporal context to improve biosurveillance. Proceedings of the National Academy of Sciences of the United States of America 2003 Feb 18; 100(4): 1961-5. (http://www.pnas.org/cgi/reprint/100/4/1961.pdf)

    The paper investigates the effectiveness of using multi-day temporal filters for detecting simulated outbreaks of varying shapes, magnitudes, and durations into 10 years of historical daily visit data from a major tertiary-care metropolitan teaching hospital. Their results show that compared with the standard 1-day approach, the multiday detection approach significantly increases detection sensitivity and decreases latency while maintaining a high specificity.

24. Rogerson PA, Yamada I. Approaches to syndromic surveillance when data consist of small regional counts. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 79-85. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

    This paper reviews cumulative sum (CUMSUM) methods for normal and Poisson-distributed variables and describes how to modify the Poisson CUMSUM approach to allow the expected counts to vary. This paper also discusses how the approach can be used to monitor neighborhoods made up of contiguous regional units and applies the approaches to data on lower respiratory infection episodes reported by Boston-area clinicians.

25. Stoto MA, Schonlau M, Mariano LT. Syndromic Surveillance: Is it Worth the Effort? Chance 2004; 17(1):19-24.

    This paper addresses the question of whether syndromic surveillance is worth the effort and more importantly the cost. The impact of false alarms is addressed and a simulation study to give some indication of the size and speed that outbreaks much attain before they are detectable are discussed. The authors conclude that the benefits of syndromic surveillance have not yet been established, but that the potential beyond bioterrorism may make syndromic surveillance worth the effort.

26. Wagner, MM. Models of Computer-Based Outbreak Detection. Technical Report. October 2, 2000. [Accessed March 11, 2003]. (Technical Report – Under review)

    This paper describes a computational model, the inputs and outputs of a system and the algorithms required, of computer-based surveillance for detecting disease outbreaks.

27. Wallenstein S, Naus J. Scan statistics for temporal surveillance for biologic terrorism. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 74-78. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This study compares two different statistical methods, which are both based on a number of observations in a moving time window. The authors use brucellosis data collected by CDC to illustrate how these analyses can be performed.

28. Wong W, Moore A, Cooper G, Wagner M. Rule-Based Anomaly Pattern Detection for Detecting Disease Outbreaks. [Accessed March 11, 2003]. (http://www.autonlab.org/autonweb/papers/y2002/14622.html?branch=1&language=2)
    This paper presents a rule-based algorithm for performing early detection of disease outbreaks by searching a database of emergency department cases for anomalous patterns. The algorithm is compared against a standard detection algorithm by using simulated data, and the algorithm had significantly better detection times for common significance thresholds while having a slightly higher false positive rate.

29. Wong W, Moore A, Cooper G, Wagner M. Rule-Based Anomaly Pattern Detection for Detecting Disease Outbreaks. Journal of Urban Health. 2003 Jun;80 Suppl 1:I66-I75.
    This paper presents a rule-based algorithm for performing early detection of disease outbreaks by searching a database of emergency department cases for anomalous patterns.

30. Wright M, Perencevich EN, Novak C, Hebden JN, Standiford HC, Harris AD. Preliminary Assessment of an Automated Surveillance System for Infection Control. Infection Control and Hospital Epidemiology 2004 Apr; 25(4): 325-332.
    This paper describes the use of automated control charts for the detection of possible outbreaks in an academic medical center. The study evaluated control charting and alert detection data comparing an automated surveillance application with standard infection control practices. The article suggests that automated surveillance systems could be an important tool for infection control programs as they reduce healthcare associated infections and improve patient safety.

C. Informatics (Development and Implementation of Surveillance Systems)

- **Manual Information Systems: Require data abstraction or forms to be completed outside of the clinical work flow (both long-term and short-term)**

1. Arizona Department of Health Services. Syndromic Disease Surveillance in the Wake of Anthrax Threats and High Profile Public Events. Prevention, Publication of the Bureau of Epidemiology & Disease Control Services. January/February 2002, Vol. 16, No. 1. (www.azdhs.gov/diro/pio/preventionbulletin/janfeb02.pdf). (Newsletter)
    This newsletter article provides a brief synopsis of an enhanced surveillance project using aberration detection model, implemented in 15 emergency departments in Arizona during the study period of Oct 27-Nov 18, 2001.

2. County of Los Angeles, Department of Health Services, Acute Communicable Disease Control, Special Studies Report 2000. Democratic National Convention – Bioterrorism syndromic surveillance. [Accessed March 11, 2003]. (http://www.lapublichealth.org/acd/reports/spclrpts/spcrpt00/DemoNatConvtn00.pdf)
   This report describes a drop-in surveillance system for the Democratic National Convention held in Los Angeles in August 2000.

3. CDC/ MMWR. Syndromic surveillance for bioterrorism following the attacks on the World Trade Center. Sept 11, 2002/ 51 (Special issue); 13-15. (http://www.cdc.gov/mmwr/preview/mmwrhtml/mm51SPa5.htm)
   This report describes the operational and maintenance aspects of conducting syndromic surveillance for bioterrorism and demonstrates the limitations of drop-in systems that rely on manual data collection.

4. Das D, Weiss D, Mostashari F, Treadwell T, McQuiston J, Hutwagner L, Karpati A, Bornschlegel K, Seeman M, Turcios R, Terebuh P, Curtis R, Heffernan R, Balter S. Enhanced Drop-in Syndromic Surveillance in New York City Following September 11, 2001. Journal of Urban Health. 2003 Jun;80 Suppl 1:I76-I88.
   This report describes a drop-in emergency department syndromic surveillance system implemented in New York City from September 14 to October 12, 2001.

5. Hadler JL, Siniscalchi A, *et al*. Hospital admissions syndromic surveillance—Connecticut, October 2001—June 2004. MMWR Morb Mortal Wkly Rep. 2005 Aug 26; 54 Suppl: 169-73. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a27.htm)
   This report describes the syndromic surveillance reporting system in Connecticut Department of Public Health (HASS). The system continuously monitors daily nonelective hospital admissions for 11 syndromes.

6. Jorm LR. Thackway SV, Churches TR, Hills MW. Watching the Games: public health surveillance for the Sydney 2000 Olympic Games. J Epidemiol Community Health. 2003 Feb;57(2):102-8.
   This paper describes the development of the public health surveillance system for the Sydney 2000 Olympic Games; documents its major findings; and discusses the implications for public health surveillance for future events.

7. Miller JR, Mikol Y. Surveillance of diarrheal disease in New York City. J Urban Health. 1999; 76:388-390.
   This paper briefly describes three syndromic surveillance systems used to monitor nonspecific indicators of diarrheal disease in New York City. The three systems provide additional tools to determine when additional investigation regarding disease occurrence is warranted and to hasten the recognition of an outbreak. Data for one component of the surveillance program are presented to illustrate the type of data generated by this surveillance method.

8. Moran GJ, Talan DA. Update on emerging infections: news from the Centers for Disease Control and Prevention. Annals of Emergency Medicine 2003; 41(3): 414-418.

This update, provided by the CDC and EMERGEncy ID net, reports the implementation of an emergency department-based syndromic surveillance system following the attacks on the World Trade Center – New York City, 2001.

9. Osaka K, Takahashi H, Ohyama T. Testing a symptom-based surveillance system at high-profile gatherings as a preparatory measure for bioterrorism. Epidemiol Infect 2002 Dec; 129(30): 429-34. (http://www.hsph.harvard.edu/takemi/RP204.pdf)
   This paper describes a project testing symptom-based surveillance during the G8 conference in 2000 as a means of detecting outbreaks, including bio-terrorism attacks, promptly. The performance of the system was compared to a pre-existing national epidemiological surveillance of infectious disease.

10. Talan DA, Moran GJ, Mower WR, Newdow M, Ong S, Slutsker L, Jarvis WR, Conn LA, Pinner RW. EMERGEncy ID NET: an emergency department-based emerging infections sentinel network. Clin Infect Dis 1999 Feb;28(2):401-2.
    This article describes the background, development, and implementation of EMERGEncy ID NET, an interdisciplinary, multicenter, ED-based network for research of emerging infectious diseases. Data are collected during ED evaluation of patient with specific clinical syndromes, and are electronically stored, transferred, and analyzed at a central receiving center.

11. Valenciano M, Coulombier D, Cardozo BL, Colombo A, Alla MJ, Samson S, Connolly MA. Challenges for communicable disease surveillance and control in southern Iraq, April-June 2003. JAMA. 2003 Aug 6; 290(5): 654-658.
    This article describes the communicable disease surveillance and control program implemented by the World Health organization (WHO) in the Basrah governorate of southern Iraq following the war from April to May 2003. The lessons learned from the intervention are presented and communicable disease data is reported through June 2003.

12. Zelicoff A, Brillman J, Forslund DW, George JE, Zink S, Koenig S, Staab T, Simpson G, Umland E, Bersell K. The Rapid Syndrome Validation Project. Proceedings AMIA Symposium 2001; 771-5.
    The paper describes the purpose and the architecture of Rapid Syndrome Validation Project, a network-based surveillance system, which is currently being implemented in an Emergency Department.

- **Automatic Information Systems: Surveillance system analyzing medical database for aberrations; possibly long-term**

1. Baker M, Smith GE, Cooper D, Verlander N, Chinemana F, Cotterhill S, Hollyoak V, Griffiths R. Early warning and NHS Direct: a role in community surveillance? Journal of Public Health Medicine 2003 Dec; 25(4): 362-368.
   This paper describes NHS Direct, a nurse-led telephone helpline in England and Wales. Daily analysis of NHS data has the potential to detect an increase in symptoms (reported

by callers) about people in the prodromal stages of illness caused by a bioterrorist attack. Community outbreaks of more common infectious diseases are also likely to be detected.

2. Bradley CA, Rolka H, *et al*. BioSense: implementation of a national early event detection and situational awareness system. MMWR Morb Mortal Wkly Rep. 2005 Aug 26; 54 Suppl: 11-9. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a4.htm)
   This report describes the BioSense initiative and the system to support enhanced early detection of bioterrorism attacks.

3. Boulos MNK. Towards evidence-based, GIS-driven national spatial health information infrastructure and surveillance services in the United Kingdom. International Journal of Health Geographics 2004; 3(1): 1-50. (http://www.ij-healthgeographics.com/content/3/1/1)
   This article provides an overview of Geographic Information Systems (GIS) and its current applications in the United Kingdom. The paper illustrates, with examples from the literature, the different GIS methods and uses to improve community health and healthcare practices. The authors suggest that real-time GIS provide an invaluable tool for early problem detection and syndromic surveillance.

4. Brillman JC, Burr T, Forslund D, Joyce E, Picard R, Umland E. Modeling emergency department visit patterns for infectious disease complaints: results and application to disease surveillance. BMC Medical Informatics and Decision Making. 2005 Mar; 5(1): 4. (http://www.pubmedcentral.nih.gov/picrender.fcgi?artid=555597&blobtype=pdf)
   This article describes the authors' experience with the Bio-Surveillance Analysis, Feedback, Evaluation and Response (B-SAFER) system, an operational near-real-time surveillance system, using data from an emergency department (ED) in New Mexico. They found that ED chief complaints led to the timely identification of outbreaks, particularly for respiratory disease.

5. Centers for Disease Control and Prevention. Norovirus activity- United States, 2002. MMWR 2003; 52: 41-45.
   This article is part of a series on emerging infections from the Centers of Disease Control and Prevention (CDC) and the EMERGEncy ID NET, an emergency department-based and CDC-collaborative surveillance network. Information on norovirus activity is reported to help advance knowledge about communicable diseases in emergency medicine and promote cooperation between the front line of clinical medicine and public health agencies. Emergency Department Syndromic Surveillance Systems in New Hampshire and New York City proved successful in detecting an increase in emergency department visits for gastrointestinal illness.

6. Chapman WW, Cooper GF, Hanbury P, Chapman BE, Harrison LH, Wagner MM. Creating a text classifier to detect radiology reports describing mediastinal findings associated with inhalational anthrax and other disorders. J Am Med Inform Assoc 2003; 10:494-503.
   This study describes the creation of a statistical text classifier, the Identity Patient Sets (IPS) system, which was used to create a key word based model to detect chest radiograph reports consistent with the mediastinal findings of inhalational anthrax. Early

detection of patients with mediastinal anthrax findings on chest radiographs may be an important element in automated detection of an anthrax outbreak.

7. Cooper DL, Smith G, Baker M, Chinemana F, Verlander N, Gerard E, Hollyoak V, Griffiths. National symptom surveillance using calls to a telephone health advice service – United Kingdom, December 2001 – February 2003. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 179-183. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
   This paper describes a new United Kingdom (UK) surveillance system operated by the National Health Service (NHS) that examines syndromes reported to NHS Direct, a national telephone health advice service. The surveillance system has detected elevated levels of activity in specific symptoms at both national and regional levels.

8. Dembek ZF, Carley K, Siniscalchi A, Hadler J. Hospital admissions syndromic surveillance – Connecticut, September 2001 – November 2003. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 50-52. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
   This paper describes the syndromic surveillance system based on unscheduled hospital admissions called HASS that was initiated by the Connecticut Department of Health in September 2001. The system's objectives, experience and limitations are also discussed.

9. Espino JU, Wagner M, Szczepaniak C, Tsui F-C, Su H, Olszewski R, Liu Z, Chapman W, Zeng X, Ma L, Lu Z, Dara J. Removing a barrier to computer-based outbreak and disease surveillance – the RODS Open Source Project. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 32-39. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
   This paper summarizes the development of the Real-Time Outbreak and Disease Surveillance System (RODS) system, reasons behind the creation of an open-source project and plans for additional software development. The infrastructure created to allow expansion of the RODS open-source community, efforts to publicize the project, and metrics collected to assess its progress are also described.

10. Espino JU, Wagner MW, Tsui F-C, Su H-D, Olszewski RT, Liu Z, Chapman W, Zeng X, Ma, Lili, Lu ZW, Dara J. The RODS open source project: removing a barrier to syndromic surveillance. Medinfo. 2004; 11(Pt 2): 1192-6. (http://openrods.sourceforge.net/OPENRODS_MEDINFO.pdf)
    This paper describes the design of the Real-time Outbreak and Disease Surveillance (RODS) Open Source Project and its goal to accelerate deployment of computer-based syndromic surveillance software. The paper discusses the function and architecture of the software, the organization of the deployment effort, and suggestions for future development by the community.

11. Foldy SL, Barthell E, Silva J, Biedrzycki P, Howe D, Erme M, Keaton B, Hamilton C, Brewer L, Miller G, Eby E, Coles R, Pemble K, Felton C. SARS surveillance project – internet-enabled mutiregion surveillance for rapidly emerging disease. In: Syndromic

Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 215-220. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

This paper describes the objectives of the SARS Surveillance Project (SARS-SP), which was established to rapidly implement multiregional SARS surveillance in emergency departments (EDs) by using existing Internet-based tools. These objectives included creating and disseminating SARS screening forms for ED triage, constructing SARS surveillance using Regional Emergency Medicine Internet (REMI), expanding surveillance to multiple regions and evaluating the usefulness of these Internet tools for surveillance during the global epidemic.

12. Foldy SL, Biedrzycki PA, Baker BK, Swain GR, Howe DS, Gieryn D, Barthell EN, Pemble KR. The public health dashboard: a surveillance model for bioterrorism preparedness. Journal of Public Health Management and Practice 2004 May-Jun; 10(3): 234-240.

    This paper describes the implementation of a Dashboard Surveillance model, successfully piloted by the Milwaukee Health Department. This short-term, near real-time syndromic surveillance and communication tool was used to convey syndromic health trends to hospitals, emergency departments and other providers using secure Internet technology. The authors suggest that similar surveillance and communications systems could provide multiple benefits to Emergency departments, and public health and emergency response.

13. Foldy S, Biedrzycki PA, Barthell EN, Healy-Haney N, Baker BK, Howe DS, Gieryn D, Pemble KR. Syndromic surveillance using regional emergency medicine internet. Annals of Emergency Medicine 2004 Sept; 44 (3): 242-246.

    This study addresses the utility of emergency department (ED) syndromic surveillance using a regional emergency medicine Internet application to minimize impact on ED and public health staffing. The results of regional surveillance for two time periods are discussed, which demonstrate that a regional emergency medicine Internet approach can permit implementation of multisite syndromic surveillance without additional staff.

14. Forslund DW, Joyce EL, Burr T, Picard R, Wokoun D, Umland E, Brillman JC, Froman P, Koster F. Setting Standards for improved syndromic surveillance. IEEE Engineering in Medicine and Biology Magazine 2004 Jan-Feb; 23(1): 65-70.

    This article describes the importance of standardized components in medical surveillance as well as the value of a federated approach to syndromic surveillance. The authors describe an open, standard architecture that has been effective in medical surveillance, outline a differential diagnosis enhancement to syndromic surveillance that may increase sensitivity and specificity of the surveillance process, and urge collaboration and standardization of syndromic and medical surveillance at the data and functional level.

15. Gesteland PH, Gardner RM, Tsui F, Espino JU, Rolfs RT, James BC, Chapman WW, Moore AW, Wagner MM. Automated syndromic surveillance for the 2002 Winter Olympics. Journal of the American Medical Informatics Association 2003 Nov-Dec; 10(6):547-554. (http://www.pubmedcentral.gov/picrender.fcgi?tool=pmcentrez&action=stream&blobtype=pdf&artid=264432)

    This article describes the implementation of the Real-time Outbreak and Disease Surveillance (RODS) system in Utah for the 2002 Winter Olympic Games. The

automated syndromic surveillance system was deployed on a highly accelerated schedule and the strategies and challenges of implementing such a system in a short time are discussed.

16. Gesteland PH, Wagner MM, Chapman WW, Espino JU, Tsui F, Gardner RM, Rolfs RT, Dato V, James BC, Huang PJ. Rapid deployment of an electronic disease surveillance system in the state of Utah for the 2002 Olympic winter games. Proceedings AMIA Symposium 2002;: 285-9.
    This paper details the experience of deploying the Real-time Outbreak and Disease Surveillance (RODS) system in Utah during a 28-day period spanning the 2002 Olympic winter games. The paper addresses health system and health department concerns, data sharing agreements, project management, implementation, and public health integration.

17. Hammond L, Papadopoulous S, Johnson C, MaWhinney S, Nelson B, Todd, JK. Use of an internet-based community surveillance network to predict seasonal communicable disease morbidity. Pediatrics 2002 Mar; 109(3):414-418.
    This paper describes an Internet-based surveillance system that collected and displayed information about pediatricians' office visits and laboratory results at a pediatric hospital. It was designed to predict the number of severe cases that would later require hospital admission. The system was also helpful in providing physicians with information about the cause of seasonal disease in their communities.

18. Heffernan R, Mostashari F, Das D, Besculides M, Rodriguez C, Greenko J, Steiner Sichel L, Balter S, Karparti A, Thomas P, Phillips M, Ackelsberg J, Lee E, Leng J, Hartman J, Metzger K, Rosselli R, Weiss D. New York City syndromic surveillance systems. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 25-27. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This paper describes the syndromic surveillance systems currently in operation at the New York City Department of Health and Mental Hygiene. The usefulness of these systems and future plans are also discussed.

19. Heffernan R, Mostashari F, Das D, Karpati A, Kulldorff M, Weiss D. Syndromic surveillance in public health practice, New York City. Emerging Infectious Diseases 2004 May; 10(5): 858-864. (http://www.cdc.gov/ncidod/eid/vol10no5/pdfs/03-0646.pdf)
    This article describes the syndromic surveillance system established by the New York City Department of Health and Mental Hygiene in 2001. The electronic system monitors emergency department chief complaint data in order to aid the early detection of disease outbreaks. The methods and chief results from the first year of its implementation are discussed.

20. Irvin CB, Nouhan PP, Rice K. Syndromic analysis of computerized emergency department patients' chief complaints: an opportunity of bioterrorism and influenza surveillance. Annals of Emergency Medicine 2003; 41(4): 447-452.
    This paper describes a web-based surveillance system that analyzes computerized emergency department patient's chief complaints for syndromes related to terrorism and sends an alert e-mail message when an outbreak is detected.

21. Lazarus R, Kleinman K, Dashevsky I, Adams C, Kludt P, DeMaria A Jr, Platt R. Use of automated ambulatory-care encounter records for detection of acute illness clusters, including potential bioterrorism events. Emerging Infectious Disease 2002 Aug; 8(8): 753-60. (http://www.cdc.gov/ncidod/eid/vol8no8/pdf/02-0239.pdf)
    This paper describes an automated system that produces information within 24 hours about illness clusters, based on ambulatory-care visits and telephone calls. This system complements emergency room and hospital-based surveillance by adding the capacity to rapidly identify cluster of illness, including potential bioterrorism events.

22. Lazarus R, Kleinman KP, Dashevsky I, DeMaria A., Platt R. Using automated medical records for rapid identification of illness syndromes (syndromic surveillance): the example of lower respiratory infection. BMC Public Health 2001; 1(1): 9. (http://www.biomedcentral.com/1471-2458/1/9)
    This paper describes some of the technical and methodological issues encountered in developing a surveillance system for lower respiratory infection based on automated ambulatory care electronic encounter records from a large HMO and multi-specialty group practice.

23. Lewis M, Pavlin J, Mansfield J, O'Brien S, Boomsma L, Elbert Y, Kelley P. Disease outbreak detection system using syndromic data in the greater Washington DC area. American Journal of Preventive Medicine 2002; 23(3) 180-186. (http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VHT-46T9D7X-6&_coverDate=10%2F31%2F2002&_alid=86644084&_rdoc=1&_fmt=&_orig=search&_qd=1&_cdi=6075&_sort=d&view=c&_acct=C000046148&_version=1&_urlVersion=0&_userid=856389&md5=c81b95d2cee45e3a34db58929a5508e3)
    This paper describes the implementation of the centralized Department of Defense medical information systems, ESSENCE, in detecting outbreaks diagnoses based on ICD-9-CM codes obtained daily from 99 military emergency rooms and primary care clinics across the Washington, DC region from December 1999 to January 2002.

24. Lober WB, Baer A, Karras BT, Duchin JS. Collection and integration of clinical data for surveillance. Medinfo. 2004; 2004:1211-5.
    This paper briefly describes three implementations of Emergency Department (ED) based syndromic surveillance in Seattle and King County, WA. The current, second-generation automated reporting system is then described in detail, which collects multi-tiered data from ED and primary care visits and provides automated transmission of normalized data.

25. Lober WB, Trigg L, Karras B. Information system architectures for syndromic surveillance. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 203-208. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This paper describes the essential architectural components of a syndromic surveillance information system in the context of basic and applied research in data integration. Existing and potential architectural approached to data integration are also described.

26. Lober WB, Trigg LJ, Karras BT, Bliss D, Ciliberti J, Stewart L, Duchin JS. Syndromic surveillance for bioterrorism using automated collection of computerized discharge diagnoses. Journal of Urban Health. 2003 Jun; 80 Suppl 1:I97-I106. (Additional information located at http://cirg.washington.edu/public/cirg/ssic.php)
    This article describes the Syndromic Surveillance Information Collection system, in place since June 2001, that collects, integrates, and displays data from emergency department and urgent care departments and primary care clinics by automatically mining data from the information systems of those facilities.

27. Lombardo J, Burkom H, Elbert E, Magruder S, Lewis SH, Loschen W, Sari J, Sniegoski C, Wojcik R, Pavlin J. A Systems Overview of the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE II). J Urban Health 2003; 80: i32-i42.
    This paper describes the system, data sources, electronic data collection and formatting, detection, internet-based information distribution, and evaluation of performance of ESSENCE II, an electronic surveillance system that uses syndromic and nontraditional health information to provide early warning of abnormal health conditions in the National Capital Area.

28. Loonsk JW. BioSense – A national initiative for early detection and quantification of public health emergencies. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 53-55. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This paper describes BioSense, an initiative to advance early detection capabilities in the United States by promoting more efficient data acquisition and improving technology associated with near real-time reporting.

29. McKenna VB, Gunn JE, Auerbach J, Brinsfield KH, Dyer KS, Barry MA. Local collaborations: development and implementation of Boston's bioterrorism surveillance system. Journal of Public Health Management and Practice 2003 Sept-Oct; 9(5): 384-393.
    This article describes the implementation of an active surveillance system for bioterrorism and infectious diseases developed by the Boston Public Health Commission. The authors conclude that the development of a syndromic system will build on the effectiveness of the current volume based system.

30. Paladini M. Daily Emergency Department Surveillance System – Bergen County, New Jersey. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 47-49. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This paper describes the Daily Emergency Department Surveillance System, which collects and analyzes emergency department data from four hospitals in Bergen County, New Jersey. Operation and experiences of the system are also described in addition to the obstacles and benefits encountered.

31. RODS Demonstration Systems in Public Health Surveillance: Completed, Ongoing, and Planned. July 1, 2002. [Accessed March 11, 2003]. (Technical Report)
    This report summarizes the goals and results of RODS projects—completed, ongoing, and planned.

32. Sokolow LZ, Grady N, *et al*. Deciphering data anomalies in BioSense. MMWR Morb Mortal Wkly Rep. 2005 Aug 26; 54 Suppl: 133-9. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a21.htm)
    This report examines the role of the CDC BioSense analysts in identifying and solving data anomalies in the BioSense early event surveillance system. It discusses the limitations of this application and possible steps to improve national syndromic surveillance methodology.

33. Tsui FC, Espino JU, Wagner MM, Gesteland P, Ivanov O, Olszewski R, Liu Z, Zeng X, Chapman WW, Wong WK, Moore AW. Data, Network, and Application: Technical Description of the Utah RODS Winter Olympic Biosurveillance System. Proceedings AMIA Symposium 2002;: 815-9.
    This paper describes the technical parts at the data, network, and application level of Utah RODS used to remotely monitor the health status of Utah from the University of Pittsburgh during the 2002 Winter Olympics.

34. Tsui F, Espino JU, Dato VM, Gesteland PH, Hutman J, Wagner MM. Technical Description of RODS: A Real-time Public Health Surveillance System. Journal of the American Medical Informatics Association 2003 Sept; 10(5):399-408. (http://www.jamia.org/cgi/reprint/10/5/399)
    This report provides a detailed description of the current version of the Real-time Outbreak Detection and Disease Surveillance (RODS) system, a computer-based public health surveillance system for early detection of disease outbreaks. The RODS system continues to be an important resource for implementing, evaluating, and applying new methods of public health surveillance.

35. Wagner MM, Espino J, Tsui F-C, Gesteland P, Chapman W, Ivanov O, Moore A, Wong W, Dowling J, Hutman J. Syndrome and outbreak detection using chief-complaint data – experience of the Real-Time Outbreak and Disease Surveillance (RODS) project. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 28-31. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This paper describes the experience of the RODS project in collecting and analyzing patient chief complaints. The technical approach and prospective evaluation of the project are also discussed.

36. Wagner MM, Tsui F-C, Hogan W, Hutman J, Hersh J, Neill D, Moore A, Parks G, Lewis C, Aller R. National Retail Data Monitor for public health surveillance. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 40-42. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This paper describes the National Retail Data Monitor (NRDM), a public health surveillance tool that collects and analyzes daily sales data for over-the-counter (OTC) healthcare products from over 15,000 retail stores in the United States.

37. Yih WK, Caldwell B. Harmon R, Kleinman K, Lazarus R, Nelson A, Nordin J. Rehm B, Richter B, Ritzwoller D, Sherwood E, Platt R. National Bioterrorism syndromic surveillance

demonstration program. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 43-46. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

This paper describes the National Bioterrorism Syndromic Surveillance Demonstration Program, which identifies and analyzes new cases of illness from electronic ambulatory records from participating health-care organizations. Program goals, operation and experiences of the system and ongoing activities are also described.

38. Yuan CM, Love S, Wilson M. Syndromic surveillance at hospital emergency departments – southeastern Virginia. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 56-58. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

This paper describes the use of active syndromic surveillance at hospital emergency departments (EDs) in southeastern Virginia. The value of the ED-based system was examined by analyzing the effectiveness of the cumulative sum algorithm in identifying unusual disease events from syndromic data.

D. Syndromic Surveillance Information Systems (Internet websites)

- **Manual Information Systems**

1. **Enhanced Consequence Management Planning and Support System** (ENCOMPASS) (http://www.darpa.mil/DSO/trans/pdf/encompass.pdf) is a computer-based program that assists in disaster and patient information management. It provides incident commanders and first responders with a common operational picture of the scene including fast-time updates, location and identification of resources and personnel, and a situational analysis.

2. **Lightweight Epidemiological Advanced Detection Emergency Response System (LEADERS)** (http://www.scenpro.com/) provides immediate, web-based exchange of critical medical monitoring and incident response information among participating organizations.

3. **Rapid Syndrome Validation Project (RSVP)** (http://www.ca.sandia.gov/chembio/implementation_proj/rsvp/index.html) is a real-time, full-time medical database that is used to track and report and outbreaks of syndromes - signs and symptoms - rather than positive diagnoses of specific diseases. RSVP is able to displaying syndromic information geographically and temporally.

- **Automatic Information Systems**

1. **Biological Spatio-Temporal Outbreak Reasoning Module (BioSTORM)** (http://smi-web.stanford.edu/projects/biostorm/) is a research program to develop and evaluate intelligent systems for epidemic detection and characterization.

2. **Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE)** (http://www.geis.ha.osd.mil/GEIS/SurveillanceActivities/ESSENCE/ESSENCE.asp) has been based on downloading Ambulatory Data System (ADS) diagnoses from 104 primary care and emergency clinics within a 50-mile radius of Washington, DC. The diagnostic codes are grouped into "syndromic clusters" consistent with emerging infections including bioterrorism.

3. **The RODS Laboratory** (http://rods.health.pitt.edu/) is a collaboration between researchers at the University of Pittsburgh and the Auton Lab in Carnegie Mellon University's School of Computer Science. Drs. Wagner, Tsui, and Espino founded the laboratory in 1999 to investigate methods for real-time detection and assessment of disease outbreaks. Current research interests of the faculty include algorithm development, assessment of novel types of surveillance data, natural language processing and analyses of detectability (described in Publications and Research).

E. Surveillance Evaluation

1. Bravata DM, McDonald KM, Smith WM, Rydzak C, Szeto H, Buckeridge DL, Haberland C, Owens DK. Systematic review: surveillance systems for early detection of bioterrorism-related diseases. Annals of Internal Medicine 2004; 140: 910-922. (http://www.annals.org/cgi/reprint/140/11/910.pdf)
   This paper presents the available data on existing surveillance systems of illnesses and syndromes potentially related to bioterrorism and published evaluation data on these systems are also discussed The authors provide a systematic review of 115 systems, 29 of which were designed for surveillance of syndromes associated with bioterrorism-relevant pathogens.

2. Buckeridge DL, Switzer P, *et al*. An evaluation model for syndromic surveillance: assessing the performance of a temporal algorithm. MMWR Morb Mortal Wkly Rep. 2005 Aug 26; 54 Suppl: 109-15. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a18.htm)
   This report described a model for simulating cases that may result from exposure to anthrax. The model is used to evaluate the ability of syndromic surveillance to detect an outbreak after a possible aerosol release.

3. Cassa CA, Iancu K, *et al*. A software tool for creating simulated outbreaks to benchmark surveillance systems. BMC Med Inform Decis Mak. 2005 Jul 14; 5:22. (http://www.biomedcentral.com/1472-6947/5/22)
   The software tool, AEGIS Cluster Creation Tool (AEGIS-CCT) is described in this paper. AEGIS-CCT enables users to create simulated clusters with controlled features. It may be useful for automating the testing and validation of spatial and temporal cluster detection algorithms.

4. CDC. Framework for evaluating public health surveillance systems for early detection of outbreaks; recommendations from the CDC Working Group. MMWR 2004; 53(No. RR-5):1-13. (http://www.cdc.gov/mmwr/PDF/rr/rr5305.pdf)

This report expands on previous guidelines for evaluating public health surveillance systems, emphasizing timeliness for outbreak detection and dissecting the relationship between sensitivity and predictive value as critical attributes. Though the framework is best handled with actual data to demonstrate the attributes of the system, the framework can also be applied to systems that are in early stages of development or in the planning phase.

5. Edge VL, Pollari F, Lim G, Aramini J, Sockett P, Martin SW, Wilson J, Ellis A. Syndromic surveillance of gastrointestinal illness using pharmacy over-the-counter sales. A retrospective study of waterborne outbreaks in Saskatchewan and Ontario. Can J Public Health. 2004 Nov-Dec; 95(6):446-50.

   This study investigated how pharmacy over-the-counter (OTC) sales trends compared retrospectively to both number of emergency room visits and cases of gastrointestinal illness in order to evaluate the potential use of OTC sales data for syndromic surveillance.

6. Fleischauer AT, Silk BJ, Schumacher M, Komatsu K, Santana S, Vaz V, Wolfe M, Hutwagner L, Cono J, Berkelman R, Treadwell T. The validity of chief complaint and discharge diagnosis in emergency department-based syndromic surveillance. Acad Emerg Med 2004 Dec; 11(12): 1262-1267.

   This article describes the evaluation of a "drop-in" syndromic surveillance system in Arizona by comparing syndromic categorization in the emergency department (ED) with chief complaints and ED discharge diagnoses from medical records. The findings suggest that the use of ED discharge diagnoses, in addition to or instead of chief complaints, may increase surveillance validity for both automated and drop-in syndromic surveillance systems.

7. Henry JV, Magruder S, Snyder M. Comparison of office visit and nurse advice hotline data for syndromic surveillance – Baltimore – Washington, D.C., Metropolitan Area, 2002. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 112-116. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

   This study examined whether Kaiser Permanente of the Mid-Atlantic States (KPMAS) nurse advice hotline data, characterized into Electronic Surveillance System for Early Notification of Community-Based Epidemics II (ESSENCE II) syndrome groups, would be able to predict the syndrome diagnoses made during future KPMAS office visits.

8. Karras BT, Lober WB, Smith GT. Evaluating the new electronic disease surveillance systems. University of Washington School of Public Health & Community Medicine 2002 Fall/Winter; 22-23. (http://healthlinks.washington.edu/nwcphp/nph/f2002/surveillance_f2002.pdf)

   This article outlines 10 points for public health professionals to consider when making decisions about the utility of new electronic surveillance systems. These points are categorized under vendor, validation, flexibility, expandability, operation/ timeliness/ reliability, notification, usability, security, compatibility, and supportability.

9. Kawana A, Teruya K, *et al*. Trial surveillance of cases with acute respiratory symptoms at IMCJ Hospital. Jpn J Infect Dis. 2005 Aug; 58 (4): 241-3. (http://www.nih.go.jp/JJID/58/241.html)

    This paper discusses their hospital surveillance system for severe acute respiratory syndrome (SARS) outbreak. Case was defined as fever of over 38 degrees C and with acute respiratory symptoms. During the study period, no SARS cases were identified.

10. Kulldorff M, Zhang Z, Hartman J, Heffernan R, Huang L, Mostashari F. Benchmark data and power calculations for evaluating disease outbreak detection methods. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 144-151. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

    The first goal of this study was to create simulated benchmark data sets based on the geography and population of New York City in order to evaluate the statistical power of early outbreak-detection methods. The second goal was to estimate and compare the power of prospective purely temporal scan statistics with prospective space-time scan statistics. The authors concluded that the benchmark data sets created could be used successfully and that space-time methods might be necessary for early detection of localized outbreaks.

11. Lenaway DD, Ambler A. Evaluation of a school-based influenza surveillance system. Public Health Reports 1995 May-June; 110(3): 333-337.

    The Boulder-County Health Department, CO developed, piloted, and implemented a school-based surveillance system in 1988. Using the CDC guidelines for evaluation surveillance systems, the system was evaluated against a preexisting communicable disease sentinel surveillance system.

12. Lombardo JS, Burkom H, Pavlin J. ESSENCE II and the framework for evaluating syndromic surveillance systems. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 159-165. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

    This paper describes an evaluation of the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE) II, according to the CDC framework for evaluating syndromic surveillance systems.

13. Mandl KD, Reis B, Cassa C. Measuring outbreak-detection performance by using controlled feature set simulations. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 130-136. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

    This report describes an approach to evaluating public health surveillance systems for early detection of outbreaks. Stages of outbreak detection and procedures for benchmarking performance are described. Approaches to setting parameters for simulations are discussed and metrics for detection performance are proposed. Experiments using semisynthetic datasets with simulated outbreaks defined by a controlled feature set are also reviewed.

14. Metzger KB, Hajat A, Crawford M, Mostashari F. How many illness does one emergency department visit represent? Using a population-based telephone survey to estimate the syndromic multiplier. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 106-111. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

This study examines the demographic characteristics of new Yorkers with recent flu-like or diarrheal illness, describes the behaviors associated with having flu-like illness and estimates the citywide burden for selected illness by calculating the syndromic multiplier. The authors conclude that population-based survey data can be used in conjunction with syndromic surveillance data to better understand the relation between nonspecific health indicators and the burden of certain illnesses in the community and to asses the representativeness of different syndromic data sources.

15. Mostashari F, Fine A, Das D, Adams J, Layton M. Use of ambulance dispatch data as an early warning system for communitywide influenza like illness, New York City. Journal of Urban Health. 2003 Jun;80 Suppl 1:I43-I49.

This article describes an evaluation of a surveillance methodology based on electronic records of ambulance dispatches to detect communitywide respiratory outbreaks.

16. Nordin JD, Goodman MJ, *et al*. Simulated anthrax attacks and syndromic surveillance. Emerging Infect Dis. 2005 Sep; 11 (9): 1396-400. (http://www.cdc.gov/ncidod/EID/vol11no09/05-0223.htm)

The authors measured sensitivity and timeliness of a syndromic surveillance system to detect simulated anthrax releases. The space-time scan statistic was used in the analysis. They concluded that timeliness and completeness of detection of events varied by rate of infection.

17. Siegrist D, Pavlin J. Bio-ALIRT biosurveillance detection algorithm evaluation. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 152-158. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

This paper describes a methodology and the results for evaluating the performance of outbreak detection algorithms used in biosurveillance. One objective was to determine if automated detection algorithms could reliably identify the onset of natural disease outbreak acting as surrogates for potential terrorist events. False positive rates were also assessed to help determine the practical relevance for public health surveillance.

18. Sosin, DM. Draft framework for evaluating syndromic surveillance systems. Journal of Urban Health 2003; 80(2): i8-i13.

This paper highlights the CDC draft framework for evaluating syndromic surveillance systems for bioterrorism preparedness.

19. Sosin DM, DeThomasis J. Evaluation challenges for syndromic surveillance – making incremental progress. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 125-129. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)

This paper uses abstracts from the 2003 National Syndromic Surveillance Conference to describe the progress made in system evaluation during 2003. Ongoing challenges and recommended steps for the future are also discussed.

20. Steiner-Sichel L, Greenko J, Heffernan R, Layton M, Weiss D. Field investigations of emergency department syndromic surveillance signals – New York City. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 184 - 189. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This paper describes three investigations conducted by the New York City Department of Health and Mental Hygiene to characterize emergency department syndromic signals by person, place and time and to determine whether the signals represented true infectious disease outbreaks.

21. Suyama J, Sztajnkrycer M, Lindsell C, Otten EJ, Daniels JM, Kressel AB. Surveillance of Infectious Disease Occurrences in the Community: An Analysis of Symptom Presentation in the Emergency Department. Academic Emergency Medicine 2003 Jul;10 (7):753-63.
    The purpose of the study was to assess the ability of a simulated syndromic surveillance system in the emergency department (ED) setting to predict infectious disease trends in the community by comparing frequency changes of symptom presentation in the ED with known cases of class A diseases identified by public health officials over a two-year period.

22. Terry W, Ostrowsky B, Huang A. Should we be worried? Investigation of signals generated by an electronic syndromic surveillance system – Westchester County, New York. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 190-195. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
    This paper describes the Westchester County Department of Health's (WCDH) experience in responding to syndromic surveillance signals during the first 9 months after the system was implemented and the response to signals detected by the county's syndromic surveillance system.

23. Weber SG, Pitrak D. Accuracy of a local surveillance system for early detection of emerging infectious disease. JAMA. 2003 Aug 6; 290(5):596-598.
    This article addresses the performance of a hospital-based syndromic surveillance system based on ICD-9 coding data in detecting a West Nile outbreak in 2002. Based on the results, the author suggests that a significant bioterrorism attack could go undetected even by a well designed single-institution system.

24. Zhu Y, Wang W, *et al*. Initial evaluation of the early aberration reporting system—Florida. MMWR Morb Mortal Wkly Rep. 2005 Aug 26; 54 Suppl: 123-30. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a20.htm)
    This report evaluates several detection algorithms of the Early Aberration Reporting System (EARS) using simulated serially correlated syndromic data and demonstrated the need for calibrating these methods.

F. Additional Resources

1. Barthell EN, Cordell WH, Moorhead JC, Handler J, Feied C, Smith MS, Cochrane DG, Felton CW, Collins MA. The Frontlines of Medicine Project: a proposal for the standardized communication of emergency department data for public health uses including syndromic surveillance for biological and chemical terrorism. Annals of Emergency Medicine 2002 Apr; 39(4):422-9.
   The Frontlines of Medicine Project proposes to develop a nonproprietary, "open systems" approach for reporting emergency department patient data. The common element is a standard approach to sending messages from individual emergency departments to regional oversight entities that could then analyze the data received.

2. Broome C, Horton H, Tress D, Lucido SJ, Koo D. Statutory basis for public health reporting beyond specific diseases. Journal of Urban Health 2003; 80: i14-i22.
   This article provides specific information about the general disease reporting provisions in each state and also shows that the intent of these reporting laws and the HIPAA privacy rule is to support the critical disease surveillance function for the benefit of the population.

3. Drociuk D, Gibson J, Hodge J. Health information privacy and syndromic surveillance systems. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 221-225. (http://www.cdc.gov/mmwr/PDF/wk/mm53SU01.pdf)
   This paper summarizes the results of a survey of state terrorism-preparedness coordinators and state epidemiologists, who were asked to share their experiences regarding patient confidentiality and the Health Insurance portability and Accountability Act of 1996 (HIPAA) Privacy Rule requirements when implementing syndromic surveillance systems. The paper describes the authors' and others' experiences with implementation as well.

4. Kaufmann AF, Meltzer MI, Schmid GP. The economic impact of a bioterrorist attack: are prevention and postattack intervention programs justifiable? Emerging Infectious Diseases 1997. 3(2): 83-94. (ftp://ftp.cdc.gov/pub/EID/vol3no2/adobe/kaufman.pdf)
   This paper constructs a model that shows the economic impact of a bioterrorist attack. By using an insurance analogy, the model provides economic justification for preparedness measures.

5. Lopez W. New York City and State Legal Authorities Related to Syndromic Surveillance. Journal of Urban Health 2003; 80: i23-i24.
   This article describes the legal authority of New York City and State for conducting surveillance of syndromes of illness and disease that may be indicative of outbreaks or of unusual manifestations of disease in an individual.

6. National Syndromic Surveillance Conference. September 23rd - 24th, 2002 · New York, New York. (http://www.syndromic.org/con_2002.html)

7. National Syndromic Surveillance Conference. October 23rd – 24th, 2003 · New York, New York. (http://www.syndromic.org/con_2003.html)

8. National Syndromic Surveillance Conference. November 3rd – 4th, 2004 · New York, New York. (http://www.syndromic.org/con_2004.html)

G. Non-BT related resources

1. Frisen M. Statistical surveillance: optimality and methods. International Statistical Review 2003; 71(2): 403-434.
   This paper presents an overview of commonly used statistical methods, with respect to optimality, for surveillance within a number of disciplines.

2. Harcourt SE, Smith GE, Hollyoak V, Joseph CA, Chaloner R, Rehman Y, Warburton F, Ejidokin, Watson JM, Griffiths RK. Can calls to NHS Direct be used for syndromic surveillance? Commun Dis Public Health 2001; 4: 178-88.
   This study assessed whether NHS Direct, a national nurse-led telephone advice line in England, could be a useful source of surveillance data for communicable diseases, using influenza as a pilot condition.

3. Hutwagner LC, Maloney EK, Bean NH, Slutsker L, Martin SM. Using laboratory-based surveillance data for prevention: an algorithm for detecting Salmonella outbreaks. Emerging Infectious Diseases 1997; 3(3): 395-400.
   (ftp://ftp.cdc.gov/pub/EID/vol3no3/adobe/hutwagnr.pdf)
   The authors developed a computer algorithm, applying the CUSUM method, to identify outbreaks of Salmonella Enteritidis isolates in 1993. By comparing these detected outbreaks with known reported outbreaks, they estimated the sensitivity, specificity, and false-positive rates.

4. Kaninda AV, Belanger F, Lewis R, Batchassi E, Aplogan A, Yakoua Y, Paquet C. Effectiveness of incidence thresholds for detection and control of meningococcal meningitis epidemics in northern Togo. International Journal of Epidemiology. 2000 Oct;29(5):933-40.
   This paper describes a study to assess the validity of currently recommended threshold and studies other thresholds that might allow an earlier detection of meningococcal meningitis epidemics and thereby increase the impact of reactive mass vaccination campaigns.

5. Lewis R, Nathan N, Diarra L, Belanger F, Paquet C. Timely detection of meningococcal meningitis epidemics in Africa. Lancet. 2001 Jul 28;358(9278):287-93.
   The paper describes a study to assess the ability of meningitis incidence thresholds to detect epidemics in time to intervene effectively, according to the epidemiological context and completeness of case-reporting, and to explore prediction of meningitis epidemics, in areas with less than 30,000 inhabitants in Mali.

6. MacDonald RD, Farr B, Neill M, Loch J, Sawadsky B, Mazza C, Daya K, Olynyk C, Chad S. An emergency medical services transfer authorization center in response to the Toronto

severe acute respiratory syndrome outbreak. Prehospital Emergency Care 2004 Apr-Jun; 8(2):223-231.

This report describes the emergency medical services command, control, and tracking system, which was implemented to mitigate the risk of iatrogenic spread of SARS among health care facilities, workers and patients in Ontario. The authors suggest that this type of system could be capable of providing syndromic surveillance in real-time and provide the earliest indication of a potential threat to public health.

7. Moore PS, Plikaytis BD, Bolan GA, Oxtoby MJ, Yada A, Zoubga A, Reingold AL, Broome CV. Detection of meningitis epidemics in Africa: a population-based analysis. International Journal Epidemiology. 1992 Feb;21(1):155-62.

   The paper evaluates the usefulness of weekly meningitis rates derived from active surveillance data in Burkina Faso for detecting a meningitis epidemic.

8. Nordin JD, Harpaz R, Harper P, Rush W. Syndromic surveillance for measleslike illnesses in a managed care setting. Journal of Infectious Diseases 2004 May 1; 189 Suppl 1:S222-6.

   This article describes syndromic surveillance using data systems from a large managed care organization (MCO) to determine the incidence of measleslike (MLI) illness in an ambulatory population in Minnesota. The paper aims to characterize provider diagnostic and reporting behavior and explore the potential of MCO databases for conducting syndromic surveillance.

9. Proctor ME, Blair KA, Davis JP. Surveillance data for waterborne illness detection: and assessment following a massive waterborne outbreak of Cryptosporidium infection. Epidemiol Infect 1998; 120: 43-54.

   The authors examine surveillance data from eight non-traditional sources and summarize the relative strengths and weaknesses of these data and related methods for routine community-wide waterborne illness detection and their application in outbreak decision-making.

10. Quenal P, Dab W, Hannoun C, Cohen JM. Sensitivity, specificity and predictive values of health service based indicators for the surveillance of influenza A epidemics. International Journal of Epidemiology 1994; 23(4): 849-855.

    This study assesses the predictive value of health service based indicators for the detection of influenza A epidemics and validated the indicators against lab confirmed influenza. Indicators included medial activity, absenteeism from work, drug consumption, and hospital activity. The results of the study showed that the indicators were easy to collect and are useful for the surveillance of influenza epidemics.

11. Rodman JS, Frost F, Jakubowski W. Using nurse hot line calls for disease surveillance. Emerg Infect Dis 1998 Apr-Jun; 4(2):329-32. (http://www.cdc.gov/ncidod/eid/vol4no2/adobe/rod.pdf)

    In this study, nurse hot line data from Milwaukee, Wisconsin, showed more than a 17-fold increase in calls for diarrhea during the 1993 Milwaukee cryptosporidiosis outbreak. Moreover, consistent patterns of seasonal variation in diarrhea- and vomiting-related calls were detected from the Baltimore, Maryland, and Albuquerque, New Mexico, hot lines.

Analysis of nurse hot line calls may provide an inexpensive and timely method for improving disease surveillance.

12. Tappero JW, Khan AS, Pinner RW, Wenger JD, Graber JM, Armstrong LR, Holman RC, Ksiazek TG, Khabbaz RF. Utility of emergency, telephone-based national surveillance for Hantavirus pulmonary syndrome. JAMA 1996; 275 (5): 398-400.
    This paper focuses on a toll-free telephone hotline, instituted to provide updated information about unexplained respiratory illness and to serve as a passive mechanism for reporting suspected cases. This passive surveillance system was successful in rapidly identifying the widespread sporadic geographic distribution for Hantavirus pulmonary syndrome through the US and could serve as a model for similar emergencies.

13. Toubiana L, Flahault A. A space-time criterion for early detection of epidemics of influenza-like-illness. European Journal of Epidemiology 1998; 14: 465-470.
    The authors developed a method based on a space-time criterion for the early detection of epidemics of influenza-like illness, and they applied this algorithm to the last 11 epidemics (from 1986), resulting in good sensitivity and specificity.

14. Welliver RC, Cherry JD, Boyer KM, Deseda-Tous JE, Krause PJ, Dudley JP, Murray RA, Wingert W, Champion JG, Freeman G. Sales of nonprescription cold remedies: a unique method of influenza surveillance. Pediat. Res. 1979; 13: 1015-1017.
    In this paper, in addition to reporting the influenza surveillance findings of Los Angeles, sales of nonprescription cold remedies in a large supermarket chain were evaluated as an indicator of influenza activity in the community. The data suggest that monitoring sales of nonprescription cold remedies may be a useful technique of influenza surveillance, especially in years when minimal activity occurs.

15. Wethington H, Bartlett P. The RUsick2 foodborne disease forum for syndromic surveillance. Emerging Infectious Diseases 2003 Mar; 10(3):401-405. (http://www.cdc.gov/ncidod/eid/vol10no3/pdfs/03-0358.pdf)
    This article describes the RUsick2 Foodborne Disease Forum, a syndromic surveillance forum intended to increase the reporting of foodborne illness and to make the identification of suspicious clusters possible. The forum is being pilot tested in the state of Michigan and allows residents with sudden-onset symptoms of foodborne illness to compare information regarding what they ate and did before and after becoming sick. The authors suggest that this program could be adapted for use in other disease outbreaks.

H. Abstracts

1. Andersson, E. Monitoring system for detecting starts and declines of influenza epidemics. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 229.
    This study evaluates and compares a nonparametric method to the likelihood ratio method for early detection of influenza outbreaks.

2. Bassil KL, Henry B, Rea E, Varia M, Cole D. Public health surveillance for World Youth Day—Toronto, Canada, 2002. MMWR 2005; 54(Suppl): 183. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a29.htm)
   This report describes a surveillance network developed to facilitate public health response at World Youth Day in Toronto, Canada. Data was collected from multiple sources using the surveillance network and the findings were shared with the public health and WYD authorities. Activity was noted to indicate that an event would be detected if it had occurred.

3. Besculides M, Heffernan R, Mostashari F, Weiss D. Evaluation of school absenteeism data for early outbreak detection – New York City, 2001-2002. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 230.
   This study evaluates the usefulness of school absenteeism data for early outbreak detection by using linear regression models and the spatial scan statistic to assess geographic clustering.

4. Brinsfield KH, Bunn JE, Barry MA, McKenna V, Dyer KS, Sulis C. Using volume-based surveillance for an outbreak early warning system. Academic Emergency Medicine 2001; 8: 492.
   This abstract assessed whether volume-based surveillance of emergency departments (EDs) and urgent care centers (UCCs) can provide early warning of an outbreak. The abstract concludes that increases in UCC and adult ED volume correlate with influenza isolation and that volume-based surveillance may be used for mass casualty events.

5. Brownstein JS, Olson K, Kleinman K, Mandl K. Effect of site of care and age on timeliness and accuracy of syndromic surveillance data. MMWR 2005; 54(Suppl): 184. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a30.htm)
   This report describes patient subpopulations based on care sites and patient age distribution and the signal of influenza epidemics. Analysis was done using cross-sectional, time-series analyses of seven patient populations in Eastern Massachusetts. It is shown that patient age significantly influences timeliness of signal for influenza and pneumonia mortality.

6. Cassa CA, Olson K, Mandl K. System to generate semisynthetic data sets of outbreak clusters for evaluation of outbreak-detection performance. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 231.
   This study describes a method for generating simulated spatio-temporal disease cluster data to assist with evaluating the performance of outbreak detection algorithms.

7. Chapman WW, Dowling J, Ivanov O, Olszewski B, Wagner M. Three stages of evaluation for syndromic surveillance from Chief-Complaint classification—Pennsylvania and Utah. MMWR 2005; 54(Suppl): 185. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a31.htm)
   This study quantified the performance of Complaint Classifier (CoCo) by using a three-stage evaluation process. CoCo was evaluated to determine ability to classify patients into prevalent syndromes and into rare and difficult syndromes.

8. Cho SS, Hackmyer S, Li J, Lipsman J, Meruelo O, Mottola D, Mulvey K, Pereria M, Recchia R. Establishing an automated surveillance system. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 232.
   This study describes the construction and implementation of the Community Health Electronic Surveillance System (CHESS) in Westchester County, New York.

9. Clark AB, Lawson A. Change-point detection using directional derivatives. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 233.
   This study describes a method for detecting changes in individual-level disease maps.

10. Cochrane DG, Allegra JR, Rothman J. Comparison of physician's choice of charting template to ICD9 codes for biosurveillance using an emergency department electronic medical records database. Academic Emergency Medicine 2003; 10(5): 525.
   This abstract quantifies the level of agreement between physician's choice of charting template and ICD9 codes, and it showed that there was moderate to near perfect agreement for 8 of the 9 syndromes examined.

11. Cochrane DG, Allegra J, Rothman J. Physician's choice of charting template versus ICD-9 code – agreement between two syndromic surveillance methods using emergency department electronic medical records. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 234.
   The study quantifies the level of overlap among patients selected by the physician's choice of charting template (PCCT) and the International Classification of Diseases, Ninth Revision (ICD-9) code. The authors conclude that when using electronic medical records, PCCT may be useful for real-time syndromic surveillance.

12. Cooper DL, Smith G, Loveridge P, Chinemana F, Gerard E, Joseph C, Baker M, Mant D, Watson J, Griffiths R, Zambon M. Using self-testing to augment syndromic surveillance—United Kingdom, December 2003-January 2004. MMWR 2005; 54(Suppl): 186. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a32.htm)
   A pilot study is presented that is used to investigate the feasibility of virologic sampling conducted by a national telephone health hotline, NHS, in the United Kingdom. This study demonstrates the possibility of community-based clinical surveillance that does not require sampling by a health-care worker. The methodology will allow novel approaches to be developed to integrate syndromic surveillance with virologic sampling.

13. Das D, Mostashari F, Weiss D, Balter S, Heffernan R. Monitoring over-the-counter pharmacy sales for early outbreak detection – New York City, August 2001 – September 2003. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 235.
   This study describes the use of over-the-counter (OTC) sales data from New York City pharmacies to enhance the detection of natural or intentional infectious disease outbreaks.

14. Dockrey MR, Trigg LJ, Lober WB. An information systems for 911 dispatch monitoring system and analysis. Proceeding of the AMIA 2002 Annual Symposium;: 1008.

This abstract explores the utility of 911 calls as a potential data source for an early warning system.

15. Duczmal L, Buckeridge D. Using modified spatial scan statistic to improve detection of disease outbreak when exposure occurs in the workplace—Virginia 2004. MMWR 2005; 54(Suppl): 187. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a33.htm)
    This report aimed to identify whether modification of Martin Kulldorf's spatial scan statistic by taking into account the movement of persons between home and work can improve detection of outbreaks in the workplace through simulations. A statistically significant increase in power was observed compared with the usual spatial scan statistic.

16. Fallon K, Boone D. Death certificate surveillance – New Hampshire. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 236.
    This study describes a death certificate surveillance system that is designed to identify clusters of deaths, detect deaths considered unusual, and identify deaths relevant to public health.

17. Flaherty J, Gillam M. Correlation of West Nile Virus infection with emergency department chief complaints by using a passive syndromic surveillance model. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 237.
    This study uses a passive syndromic surveillance model to analyze emergency department (ED) patient chief complaints of fever and headache, influenza-related symptoms, and viral syndrome, and correlate these data with known West Nile virus cases and with the epidemic curve of confirmed cases in northern Illinois.

18. Funk AB, Schier J, Belson M, Patel M, Rubin C, Watson W, Litovitz T, Kilbourne E. Using the Toxic Exposure Surveillance System to detect potential chemical terrorism events. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 239.
    This study describes the use of the Toxic Exposure Surveillance System (TESS), a national real-time surveillance database used to facilitate early detection of illness associated with a chemical release.

19. Gesteland PH, Rolfs R. Making Syndromes Reportable Diseases – Authorizing, Mandating, or Both? A perspective on the legal basis for syndromic surveillance. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 240.
    This abstract provides an overview of syndromic surveillance in preparation for the Salt Lake 2002 Olympic Winter Games, and the Detection of Public Health Emergencies Act passed in 2002. The authors discuss the legal basis and challenges of collecting syndromic surveillance data.

20. Goodall CR, Lent A, Halasz S, Koski E, Agarwal D, Tse S, Jacobson. Performance-critical anomaly detection—United States, December 2002-March 2004. MMWR 2005; 54(Suppl): 188.
    (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a34.htm)

This report analyzes an end-to-end modular process for early event detection, usefulness of multiple algorithms for anomaly detection and the effectiveness of using a case manager to reduce the burdens of false positives for early event detection.

21. Graham J, Buckeridge D, Choy M, Musen M. Conceptual heterogeneity complicates automated syndromic surveillance for bioterrorism. Proceedings AMIA Symposium 2002;: 1030.
    This abstract compared the case definitions for prodromes of illness due to biological weapons in 15 different syndromic surveillance systems, and they found substantial conceptual heterogeneity in the case definitions.

22. Grayson JK, Gould P. New Twist on Old Methods – Simple schemas for disease and nonbattle injury surveillance in deployment settings. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 241.
    This study describes the use of statistical process control charts and a modified current-past experience graph to track disease and nonbattle injury trends among deployed service members.

23. Green K, Miller B, Hadidi M, Zimmerman M, Danila R. Dual-model approach to syndromic surveillance using hospital emergency department data. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 242.
    This abstract describes a syndromic surveillance system, which was created by using both geographically based syndromic surveillance and time-series models.

24. Green MS, Kaufman Z. Syndromic surveillance for early location of terrorist incidents outside of residential areas. MMWR 2005; 54(Suppl): 189. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a35.htm)
    This report seeks to aid in early detection of terrorist incidents in areas outside of residential areas. The SaTScan™ software was used to conduct continuous surveillance and the CrimeStat II™ was used to compute the mean center and standard deviation for those census tracts included in the substantial clusters.

25. Hoffeld R, Candell L. Technique for rapid detection and localization of attacks with biologic agents. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 243.
    This study assessed through simulation and analysis, the Biological Attack Correlation Tracker (BACTrack) system in order to determine achievable sensitivity relative to infection rate, attack size, and participating populations.

26. Johnson JM, Gresham L, Browner D, McClean C, Ginsberg M, Wood S. From data sources to event detection – summary of the Southern California Regional Surveillance Summit. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 244.
    This abstract describes the Southern California Regional Surveillance Summit that was held in June 2003. Professionals from county and city health departments were able to

exchange information, share capacities, and explore the potential for regional collaboration.

27. Johnson JM, Hicks L, McClean C, Ginsberg M. Leveraging syndromic surveillance during the San Diego wildfires, 2003. MMWR 2005; 54(Suppl): 190. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a36.htm)
    This report discusses the use of existing syndromic surveillance capabilities to monitor the immediate impact of the wildfires in San Diego County. It was concluded that this disaster served as an "outbreak" which confirmed the importance of syndromic surveillance as a dual-use tool and the need for flexibility.

28. Kaufman Z, Cohen E, Peled-Leviatan T, Lavi C, Aharonowitz G, Dichtiar R, Bromberg M, Havkin O, Shalev Y, Marom R, Shalev V, Shemer J, Green M. Using Data on an Influenza B Outbreak To Evaluate a Syndromic Surveillance System --- Israel, June 2004, MMWR 2005; 54(Suppl): 191. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a37.htm)
    The What's Strange About Recent Events (WSARE) algorithm's performance is evaluated for anomaly pattern detection when applied to records of daily patient visits. Data from a 2004 influenza B outbreak at a small Israeli town was used and it was concluded that a centralized, comprehensive surveillance system can rapidly detect localized, fast-developing outbreaks.

29. King C, Shih F-Y, Yen M-Y, Hu F-C, Wu J-S, Chang F-K, Lin L-W, Yang J-Y, Chen H-Y, Wu T-S, Wang D-J, Chen K-T, Yu H-T, Hsiung C-A, Lu S-W, Chang C-M, Lin S-T, Fu C-J, Huang C-M, Ho M-S, Chang H, Chou J-H, Twu S-J, Su I-J, Marx M, Sobel H. Syndromic surveillance of infectious diseases in Taiwan – before and after the challenges of Severe Acute Respiratory Syndrome (SARS). In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 245.
    This study retrospectively evaluated Taiwan's respiratory syndromic surveillance system for its ability to detect severe acute respiratory syndrome (SARS).

30. Kintz J, Gregos E, Arrubin D, Sanchez J. Syndromic Tracking and Reporting System – overview and example. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 246.
    This study describes the Syndromic Tracking and Reporting System (STARS) utilized by the Hillsborough County Health Department in Florida. The system is used to acquire near real-time syndromic data from hospital emergency departments.

31. Kress A, Hess G. Addressing the concerns of data providers – lessons from the private sector. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 247.
    This abstract summarizes selected data-source types, challenges of working with shared data, and concerns relating to partnerships with data providers.

32. LaForgia B, Fiorenza L, John S, Paladini M. Daily electronic disease surveillance system—Bergen County, Paramus, New Jersey. MMWR 2005; 54(Suppl): 192. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a38.htm)
    This report discusses the Bergen County Daily Electronic Disease Surveillance System (DEDSS) that is used to analyze public health data.

33. Lawson BM, Fitzhugh E, Hall S, Hutwagner L, Seeman G. From implementation to automation – a step-by-step approach to developing syndromic surveillance systems from a public health perspective. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 248.
    This study describes a 10-step process for designing a syndromic surveillance system that incorporates multiple data sources, automated data transfer via file transfer protocol, scheduled batch analysis, and remote access to surveillance data.

34. Li C-S, Aggarwal C, Campbell M, Chang Y, Hill M, Iyengar V, Naphade M, Smith J, Wang M, Wu K, Yu P, Kress A. Site-based biosurveillance. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 249.
    This study describes the potential for using site-based biosurveillance of a geographically contained site to detect disease outbreaks.

35. Magruder SF, Marsden-Haug N, Hakre S, Coberly J, McClean C, Johnson J, Anderson A, Pavlin J. Comparisons of timeliness and signal strength for multiple syndromic surveillance data types—San Diego County, July 2003-July 2004. MMWR 2005; 54(Suppl): 193. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a39.htm)
    This report discusses the quantitative comparison of military and civilian syndromic data sources in San Diego County in terms of signal strength and timeliness. Three major historical disease outbreaks are used as points of comparison and it is suggested that a system that integrates multiple syndromic data streams into a single prospective tool might enhance the ability to detect disease outbreaks in a timely fashion.

36. Marsden-Haug N, Pavlin J, Foster V, Rechter S, Lombardo J, Lewis S. Expansion of ESSENCE for use in joint military and civilian surveillance in nine cities. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 250.
    This abstract describes the U.S. Department of Defense Joint Services Installation Pilot Project (JSIPP), which targets nine military installations as model sites for integrated surveillance, protection, and response.

37. Marsden-Haug N, Foster V, Hakre S, Anderson A, Pavlin J. Evaluation of joint services installation pilot project and BioNet syndromic surveillance systems—United States, 2004. MMWR 2005; 54(Suppl): 194. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a40.htm)
    This study measured the Joint Services Installation Pilot Project (JSIPP) and BioNet users' perspectives of syndromic surveillance and the use of Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE) IV. Survey response rate showed that users still have doubts about these system's utilities.

38. Marx MA, Rodriguez C, Greenko J, Das D, Mostashari F, Balter S, Heffernan R, Layton M, Weiss D. Investigation of diarrheal illness detected through syndromic surveillance after a massive blackout – New York City, August 2003. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 251.
    This abstract describes a case-control study to determine risk factors for diarrheal illness detected through syndromic surveillance among patients who visited emergency departments after a massive blackout in New York City.

39. Metzger K, Mostashari F, Kendall M. Comparison of outpatient visit and emergency department data for use in syndromic surveillance—New York City, 20012004. MMWR 2005; 54(Suppl): 195. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a41.htm)
    This report is using outpatient and emergency department data from all 11 public hospitals in New York City to compare the monitoring of respiratory and gastrointestinal illness. The evaluation indicates that these data sources may be useful for syndromic surveillance in conjunction with ED data.

40. Mirhaji P, Lillibridge S, Richesson R, Zhang J, Smith J. Semantic approach to public health situation awareness – design and methodology. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 252.
    This abstract describes a prototype system that seeks to demonstrate the utility of knowledge-intensive approaches in integrating heterogeneous information, eliminating the effects of incomplete and poor-quality surveillance data, reducing uncertainty in syndrome and aberration detection, and enabling visualization of complex information structures in surveillance settings.

41. Mocny M, Cochrane DG, Allegra JR, Nguyen T, Heffernan RT, Pavlin J, Rothman J. A comparison of two methods of biosurveillance of respiratory disease in the emergency department: chief complaint vs. ICD9 diagnosis code. Academic Emergency Medicine 2003; 10 (5):513.
    This abstract compares two existing ICD9 and chief complaint respiratory algorithms, to determine if they identified similar patients and patterns of illness when applied to the same ED database.

42. Mocny M, Cochrane D, Allegra J, Nguyen T, Pavlin J. Rothman J, Heffernan R. Improving agreement between two algorithms for biosurveillance of respiratory disease in the emergency department – chief complaint and ICD-9 code. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 253.
    This study aimed to determine whether two algorithms, one based on patient chief complaints and the other on ICD-9 codes, identified similar patterns and patient populations for respiratory illness. The study also made an attempt to improve agreement by expanding and equalizing syndrome definitions.

43. Mundorff MB, Gesteland P, Haddad M, Rolfs R. Syndromic surveillance using chief complaints from urgent-care facilities during the Salt Lake 2002 Olympic Winter Games. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 254.

This study describes the syndromic surveillance conducted in Utah during the Salt Lake 2002 Olympic Winter Games. Electronic data were routed from 19 urgent care facilities to public health authorities by using a computer program that mapped chief complaints from patients into selected syndromes.

44. Muscatello DJ, Churches T, Kaldor J, Zheng W, Chiu C, Correll P, Mannes T. Emergency department surveillance for the 2003 Rugby World Cup—New South Wales, Australia. MMWR 2005; 54(Suppl): 196. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a42.htm)
    This report discusses the development of an automated syndromic surveillance system in which the data used is collected in emergency department (ED) databases for routine patient administration. The system was used in the 2003 Rugby World Cup.

45. Neill DB, Moore A. Fast grid-based scan statistic for detection of significant spatial disease clusters. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 255.
    This study describes a multiresolution algorithm as an enhancement to the spatial scan statistic to detect significant disease clusters. This method enables users to search across all possible regions for the maximum value of the spatial scan statistic while examining only a fraction of the regions.

46. Neill DB, Moore A, Sabhnani M. Detecting elongated disease clusters. MMWR 2005; 54(Suppl): 197. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a43.htm)
    This report discusses the attempt to accelerate the spatial scan statistic in order to have rapid detection of the most significant rectangular cluster without loss of accuracy. The fast spatial scan is being applied to prospective disease surveillance using data from OTC sales.

47. Nicoll A, Smith G, Cooper D, Chinemana F, Gerard E. The public health value of syndromic surveillance: calls to a national health help-line (NHS Direct). European Journal of Public Health 2004; 14 (4) Supplement 1: 68-69.
    This abstract describes a new surveillance system in the United Kingdom that examines syndromes reported to NHS Direct, a national telephone health advice service.

48. Nordin JD, Goodman M, Kulldorf M, Ritzwoller D, Abrams A, Donahue J, Vest J. Use of modeled anthrax attacks on the Mall of America to assess sensitivity of syndromic surveillance—Minnesota, 2003-2004. MMWR 2005; 54(Suppl): 198. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a44.htm)
    This report discusses the biologic terrorism surveillance system's sensitivity and timeliness using models of anthrax release in the Mall of America. SaTscan and generalized mixed model are used in the analysis. Timeliness and completeness of detection of events varied by infection rate.

49. Olson KL, Bonetti M, Pagano M, Mandl K. Population-adjusted stable geospatial baseline for outbreak detection in syndromic surveillance. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 256.
    This abstract describes the establishment of stable baseline spatial distributions of emergency department patient data, against which abnormal spatial clusters of disease can be compared.

50. Olson KL, Mandl K. Geocoding patient addresses for biosurveillance. Proceedings of the AMIA 2002 Annual Symposium;1119.
    This abstract describes an analysis of two geocoding software packages on 3 years of emergency department visit data.

51. Pichette JL, Sherwood E, Valadez A, Jackson J, Neighbors N, Schultz J. Clinician syndromic surveillance consequent to participation in the national bioterrorism syndromic surveillance demonstration project (NBSSDP)—Central Texas, 2003. MMWR 2005; 54(Suppl): 199. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a45.htm)
    This report discusses how active clinician-based reporting can enhance automated syndromic surveillance. NBSSDP facilitated improvements that are needed in clinician-based syndromic surveillance are also discussed.

52. Raman S, Levin J, Hall D, Frey K. Using categorization of reason-for-visit strings as the basis for an outbreak detection system—Minnesota, 2002-2003. MMWR 2005; 54(Suppl): 200. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a46.htm)
    This report discusses the syndrome categorization of reason-for-visit fields for patient encounters using Support Vector Machine (SVM) and naïve Baysian categorizers, and assessed their correlations with syndrome classification based on ICD-9 codes.

53. Rodriguez VA, Silverman ME, Cochrane DG, Allegra JR, Eskin B, Rothman J. Influence of age and seasonality in an emergency department biosurveillance system. Academic Emergency Medicine 2003; 10(5): 460.
    This abstract characterized the seasonality of gastroenteritis (GE) over a longer period of time to determine the contribution of children age to the pattern. The abstract concluded that there are consistent seasonal GE peaks over the entire 15 year period, and the younger age group contributed disproportionately to the observed pattern.

54. Rogers GM, Valenti A. Visual portrayal of syndromic surveillance data by using high-low charting—Maine, 2004. MMWR 2005; 54(Suppl): 207. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a53.htm)
    This study reports the Maine Medical Center's Department of Epidemiology's syndromic surveillance on chief complaints from the emergency department (ED). A foodborne outbreak and a higher peak in the 2003-04 influenza seasons were demonstrated by the system. It was concluded that this syndromic surveillance has the potential to enhance public health surveillance by detecting abnormalities in the amount of chief complaints that are of public health concern.

55. Sebastiani P, Wang L, Mandl KD, Ramoni M. Improving outbreak detection by signal integration. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 257.
    This study describes a Bayesian network for outbreak detection in syndromic surveillance systems.

56. Shih F, Yen M-Y, Chang F-K, Lin L-W, Wu J-S, Hsiung C-A, Ho M-S, Su I, Marx M, Sobel H, King C-C. Evaluation of Taiwan's syndromic surveillance system after the Severe Acute Respiratory Syndrome – Taiwan, 2003. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 258.
    This abstract describes the feasibility of syndromic surveillance for health-care workers and delineates obstacles to the reporting process. The report summarizes the lessons learned from the 2003 outbreak of severe acute respiratory syndrome (SARS).

57. Sickbert-Bennett E, Scholer M, Butler J, Travers D, MacFarquhar J, Waller A, Ghneim G. Evaluating a syndromic surveillance system for the detection of acute infectious gastroenteritis outbreaks—North Carolina, 2004. MMWR 2005; 54(Suppl): 201. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a47.htm)
    This report used outbreak data to evaluate North Carolina's syndromic surveillance system and GI case definition. It is concluded that automated systems must be monitored to ensure proper syndrome classification and case definitions must be carefully constructed.

58. Stetson D, Bloom R, Crary D, Cheng K, McClellan G. Temporal correlation of nontraditional and traditional evidence of a natural outbreak. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 259.
    This study describes the use of a nontraditional data source (parking use data from a medical facility).

59. Stoto MA, Jain A, Diamond A, Davies-Cole J, Adade A, Washington S, Kidane G, Glymph C. Syndromic surveillance system evaluation—District of Columbia, 2001-2004. MMWR 2005; 54(Suppl): 202.
(http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a48.htm)
    This study evaluates the completeness, usefulness, and effectiveness of the District of Columbia Department of Health's syndromic surveillance system. They concluded that improvement in data completeness will allow the syndromic surveillance data the potential to early detect influenza and other disease outbreaks.

60. Thomas DM, Arouh S, Carley K, Kraiman J, Davis J. Automated anomaly detection processor for biologic terrorism early detection—Hampton, Virginia. MMWR 2005; 54(Suppl): 203.
(http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a49.htm)
    This report describes the evaluation of data-mining techniques applied in developing an Automated Anomaly Detection Processor (AADP). Using the data set from the BioWar Model and census data from Hampton, Virginia, AADP identified a simulated biologic terrorism attack occurring during the influenza season.

61. Thomas RG, Hemphill RR, Aronsky D. Syndromic surveillance for infectious disease outbreaks using chief complaint data. Annals of Emergency Medicine. 2004 Oct; 44 Supplement 4: S124. (Abstract #395) [also in: Southern Medical Journal. 2004 Oct; 97(10) Supplement: S11-S12].

    This abstract focuses on the use of chief complaint data from a Nashville university teaching hospital's emergency departments. These data were correlated with computed chief complaint data from other EDs in the Nashville area and with known influenza activity. The authors conclude that syndromic surveillance from a single institution may not result in a more effective detection of the outbreak, but suggest that real time analysis would prove valuable in mounting an effective medical response.

62. Thompson WW. Effects of sensitivity and specificity on signal-to-noise ratios for detection of influenza-associated aberrations. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 260.

    This abstract describes the application of aberration-detection models for influenza to daily death outcomes, using city-level mortality data.

63. Uhde KB, Farrell C, Geddie Y, Leon M, Cattani J. Early detection outbreaks using the BioDefend™ syndromic surveillance system—Florida, May 2002-July 2004. MMWR 2005; 54(Suppl): 204. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a50.htm)

    This report describes the evaluation of the BioDefend™ syndromic surveillance to determine if biologic terrorism attacks could be detected 24-36 hours before routine surveillance. It was concluded that health events can be recognized in near real-time through automated analysis and syndromic surveillance can be effective in early outbreak detection.

64. Van den Wijngaard C, van Asten L, Rockx B, van Pelt W, Godeke G, Koopmans M. Syndromic approach to West Nile Virus—The Netherlands, 2002-2003. MMWR 2005; 54(Suppl): 205.
(http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a51.htm)

    This report discusses a syndromic approach to initiate surveillance for West Nile virus (WNV) during active mosquito season in the Netherlands. Patients with unexplained meningoencephalitis and data of laboratory CSF tests were monitored but no endemic WNV transmission has been detected since 2002. Authors conclude that ruling out WNV as an etiologic agent in all CSF samples when no common pathogen has been detected will improve surveillance.

65. Vidal Roderio CL, Lawson A. Empirical evaluation of space-time models for surveillance of disease maps. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 261.

    This study evaluates the ability of different space-time models to detect changes in risk patterns of disease.

66. Watson WA, Litovitz T, Rubin C, Kilbourne E, Belson M, Patel M, Schier J, Funk A. Toxic exposure surveillance system. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 262.

This study describes the Toxic Exposure Surveillance System (TESS) and its current methods for early identification of potential chemical terrorism and other important public health events.

67. Wieland SC, Berger B, Mandl K. Constant specificity surveillance for real-time outbreak detection. MMWR 2005; 54(Suppl): 206. (http://www.cdc.gov/mmwr/preview/mmwrhtml/su5401a52.htm)

Modeling techniques to detect unusually high emergency department (ED) visit rates are examined and this study shows that the specificity of outbreak detection using current methods varies on multiple timescales. Autoregressive, Serfling, trimmed seasonal and wavelet-based outbreak detection models were evaluated for changes in specificity over time.

68. Wong W-K, Moore A, Cooper G, Wagner M. What's Strange About Recent Events, Version 3.0 – accounting for a changing baseline. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 263.

This abstract describes a Bayesian network method for detecting anomalous patterns in health-care data while accounting for temporal trends.

69. Yoo IS, Wang SJ, Jeong EK, Cho JP, Ahn MU, Lee JH. Analysis of results from enhanced syndromic surveillance system based on emergency department for bioterrorism and communicable disease. Emergency Medicine Australasia June 2004; 16 (Supplement 1): A60.

This study reviewed the development of and analyzed the early results from enhanced syndromic surveillance based on emergency departments during the 22nd Summer Universiade Daegu 2003 in Korea. The syndromic surveillance system is the first everyday reporting system in Korea that is based on clinical data in emergency departments during a special event.

70. Yund CB, Ottaway M, Brannen D. Practical evaluation of electronic disease surveillance systems for local public health. In: Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004; 53(Suppl): 264.

This paper describes a process for assessing the feasibility of implementing various electronic disease surveillance systems, based on existing local infrastructure.