HRSA National Bioterrorism Hospital Preparedness Program

Informational Report

Syndromic Surveillance Systems

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Syndromic Surveillance Systems

INTRODUCTION

Recently, the Health Resources and Services Administration's (HRSA), National Bioterrorism Hospital Preparedness Program (NBHPP) awarded approximately $498 million to 62 State, Territorial, and Municipal health departments to promote hospital preparedness. A dimension of preparedness includes the capacity to engage in effective surveillance for early detection of bioterrorist attacks and other outbreaks of disease.

Many experts believe that syndromic surveillance holds great promise in enhancing our ability to detect both planned and unplanned outbreaks of disease. However, the technology is young and NBHPP awardees have requested assistance in understanding the spectrum of products currently available. To address this request, HRSA has compiled information on a limited but representative cross section of systems, which is presented in this report. This report does not rank nor endorse the systems reviewed.

This report represents a first step in gathering and presenting information regarding these systems. Over time, more systems will be reviewed or invited to contribute information. Feedback from users will also be incorporated as it becomes available. As we refine our data collection tool and methods of presentation, we invite you to provide comments regarding what information you find most useful. Furthermore if you have information regarding these systems you would like to share, please provide those comments to us and we will incorporate them in future reports.

We encourage you to read this overview as well as the more detailed responses of individual system developers provided in the appendices to this report.

METHODS

To conduct this pilot evaluation a form was developed that incorporated categories described in the CDC's Draft Framework for Evaluating Surveillance Systems for Early Detection of Outbreaks (Draft 6).[1] Twenty-nine questions were developed to address the various categories of analysis within that framework. In order to standardize responses, 23 of the questions were multiple-choice, though

[1] Daniel M. Sosin, Draft Framework for Evaluating Syndromic Surveillance Systems, *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 2003; Vol. 80, No. 2, Supplement 1.

each question provided an opportunity to elaborate with narrative. An open-ended question was included in which developers were asked to describe their system in one-page summaries that identified any strengths or distinguishing features. Three system developers, and Daniel Sosin, M.D., M.P.H., author of the CDC's Draft Framework, reviewed the form. The pilot form was modified based on their input and then distributed by e-mail to representatives of various syndromic surveillance systems. In compliance with the Paperwork Reduction Act (PRA) under the Office of Management and Budget (OMB) regulations, only 9 forms were distributed in this pilot phase to a mix of public and private system developers. Some of the initial nine did not respond, so other organizations were invited to respond. A total of eight system developers responded and are included in this report. Responses were received in October and November of 2003 (others have since acquired the pilot form and have indicated their intention to volunteer information though no formal request was made). The main part of the report summarizes the data that was collected. Appendix A contains points of contact for each system identified as part of this review, Appendix B contains a one-page summary of each system provided by the developer, and Appendix C contains the raw survey responses. Table 1 lists the systems that provided data. Table 2 graphically displays the abbreviated set of questions asked in the survey with the systems' that responded to each question.

Table 1: Responding Systems

System Name	Developer
Automated Epidemiologic Geotemporal Integrated Surveillance (AEGIS)	Harvard University
Warning System for Early Detection & Biosurveillance (WEB Biosurv)	ibex Health Data Systems, Inc.
Surveil™	DSHI
Vigilent™	Ernest Young Technologies
FirstWatch™	Stout Solutions
RedBat™	ICPA
Surveillance, Monitoring, and Real Time Events (SMARTE™)	Metatomix
Rapid Syndrome Validation Project (RSVP)	Sandia National Laboratory

Table 2: Systems Responding to Survey Questions

	Responders							
Survey Question	AEGIS	WEB Biosurv	Surveil™	Vigilent™	FirstWatch™	RedBat™	SMARTE™	RSVP
1. What is the system designed to accomplish?	•	•	•	•	•	•	•	•
2. Who is the system meant to serve, i.e. who are the primary stakeholders?	•	•	•	•	•	•	•	•
3. What is the status of your system?	•	•	•	•	•	•	•	•
4. If in use, where is the system currently being employed and who is utilizing the system, i.e. the name of the institution(s), location, and a POC?	•	•	•	•	•	•	•	•

Survey Question	Responders							
	AEGIS	WEB Biosurv	Surveil™	Vigilent™	FirstWatch™	RedBat™	SMARTE™	RSVP
5. If the system is currently in use, how long has the system been employed?	•	•	•	•	•	•	•	•
6. Explain the dual use application capability of the system.	•	•	•	•	•	•	•	•
7. If the following parameters (connection/implementation fees, yearly fees) are relevant, please provide		•	•	•	•	•	•	•
8. Has your system been evaluated in a bioterrorism or natural outbreak scenario?	•	•	•	•	•	•	•	•
9. What are the data inputs (data sources) for the system? (circle all that apply)	•	•	•	•	•	•	•	•
10. Choose the corresponding system capabilities for automatic and/or manual data entries.	•	•	•	•	•	•	•	•
11. Who ensures the input data quality for your system?	•	•	•	•	•	•	•	•
12. Averaging the inputs from the different data streams, what percentage of data records are complete within 24 hours of the initial report?	•	•	•	•	•	•	•	•
13. Which of these management steps is automated?	•	•	•	•	•	•	•	•
14. If data management is manual, does the system require input by clinical staff?		•	•	•		•	•	•
15. Does the system have the capacity to De-identify and re-identify data?	•	•	•	•	•	•	•	•
16. Describe the mathematical basis for how the surveillance system analyzes and interprets data.	•	•	•	•	•	•	•	•
17. How often are data updated by the system?	•	•	•	•	•	•	•	•
18. About how often are data analyzed and charts, tables, maps refreshed by the system?	•	•	•	•	•	•	•	•
19. Please explain how the system is flexible such that it can adapt to perceived changes in risk, changing detection needs, and/or operating conditions.	•	•	•	•	•	•	•	•
20. Please explain how alarm thresholds are set by the system?	•	•	•	•	•	•	•	•
21. How are alarm notifications made by the system?	•	•	•	•	•	•	•	•
22. If that communication mode or channel is not functioning does the system automatically default to another mode?	•	•	•	•	•	•	•	•
23. What medical code sets (nomenclature) are/can be used by the system?	•	•	•	•	•	•	•	•
24. What messaging standards are used?	•	•	•	•	•	•	•	•
25. Are routine reports generated by the system?	•	•	•	•	•	•	•	•
26. What is the amount of training required for most personnel to operate the system?	•	•	•	•	•	•	•	•
27. Are there any specialized personnel that would be required for system operation?	•	•	•	•	•	•	•	•
28. Please provide a screen shot of the user interface to the system.		•	•	•	•	•	•	•
29. Please provide a one-page overview of your system noting distinguishing features and strengths of the system that set it apart from other		•	•	•	•	•	•	•

GENERAL OVERVIEW OF RESPONDING SYSTEMS

As noted above, we asked developers to provide a one-page overview of their systems. We did not impose significant constraints on the type of information offered, however we suggested that they describe any distinguishing features or strengths that may be unique to their systems. These one-page descriptions therefore provided disparate types of information and were meant to complement the structured information that was obtained through multiple-choice questions. We have paraphrased and summarized these one-page descriptions below. Some developers provided considerably more information than others and this is reflected in the varying length of the summaries. One developer, AEGIS, did not provide an overview and we have developed a brief summary on their behalf. The one-page descriptions can be found in Appendix B.

Warning System for Early Detection and Biosurveillance – WEB Biosurv™

WEB Biosurv is a dual use syndromic surveillance tool developed by Ibex and Pangaea to detect both naturally occurring and planned outbreaks of disease. It extracts information automatically without requiring clinician input and provides real time alerts when significant anomalies are detected. The vendor describes a three-step process: Acquire, Analyze and Map. In the first step the system "*Acquires*" real time or historic syndromic and disease data, demographic information, home and work addresses, and anonymous HIPAA compliant information including chief complaint, diagnosis, age, zip code etc. Epidemiological trends and potential disease clusters are identified in real-time through hospital and emergency department (ED) data collection. In the next step, the system "*Analyzes*" the data using its complaint coder, which can convert free text (scratchy/hoarse/raw throat) to recognizable categories. The *What's Strange About Recent Events?* Program (WSARE) analyzes the classified categories against a three-month "normal" dataset. Significant deviations from the norm trigger automatic notification. The map function (GIS) then displays relevant data in a geographic distribution.

Surveil™ /TriageXpert™

Surveil, developed by DSHI Systems, is a dual use surveillance solution embedded in an enhanced clinical workflow support system. It is designed to perform real-time syndromic surveillance on an entire population with a high level of sensitivity and specificity. In addition by providing triage decision support to triage clinicians it provides immediate feedback regarding individual patient management. Developed by DSHI Systems, it has a web-based architecture so no client installation is required.

The centralized knowledge base provides a single point of update and a scalable surveillance database. The TriageXpert™ Knowledge Base performs triage of >800 chief complaints and sorts them by urgency. According to the developer this can help predict needed resources and likely hood of admission, improve workflow, and reduce ED length of stay. The TriageXpert™ Encounter Database captures triage histories using codified elements, including: symptoms, signs, past medical

history, family history, and social history. Data are de-identified and a unique identifier is applied that can be used to re-identify patient if necessary. The Surveil™ Rule Library includes over 24 syndromic rules and dozens of disease rules. Quarterly updates include multipurpose and biosurveillance rules. The Surveil™ Rule Editor enables the user to create an unlimited number of multipurpose rules using thousands of clinical variables. Surveil™ Rule-based Expert System Real provides real-time patient-specific and population-based analytics. It allows rule editing and repeat analysis for emerging diseases. The Surveil™ Data Viewer permits the end user to view results in a variety of formats including graphics.

Vigilent™

Vigilent is a dual use syndromic surveillance system that is National Electronic Disease Surveillance System (NEDSS) compliant, and has formed some of the basis for the Public Health Information Network (PHIN). Vigilent™ is applicable in both long-term public health surveillance activities as well as event-based public health surveillance activities. Surveillance features include continuous data ingest, facility census and reporting. It facilitates Incident Management with a plan manager, checklist manager, message board (notification) and casualty tracking. It has Sample Tracking capability, real time PCR ingest and viewing and relevant reports. This PCR real-time processing is a critical component as it speeds up the agent identification process in the field, therefore shortening the crucial time to diagnosis. Critical Care tracking includes facility status maintenance, ambulance diversion status and resource tracking. These functional modules are supported by an administration module. Platform Services include HTTP server, J2EE application server, a portal framework and an integration hub. An Integrated Data Repository includes SQL RDBMS, OLTP and OLAP, local to national view and civilian and military support.

FirstWatch™

FirstWatch™ is a dual use syndromic surveillance system developed by Stout Solutions. It monitors live data from 9-1-1 and other public safety calls, and compares these inputs to historical and geographic patterns. Consequently, FirstWatch™ is used by police, fire and EMS, in addition to clinicians and health departments. When trigger thresholds are reached notification is sent via pager, fax, e-mail and/or smart wireless device. It can also be used to monitor hospital, ER, clinic, lab or pharmacy data, and has data-mining and monitoring capabilities relevant to a variety of data analysis applications. FirstWatch™ is designed on an open architecture and can aggregate data to provide a regional or even national perspective. This is important because adjoining 9-1-1 computers are often incompatible with one another, and because neighboring communities do not routinely share trends or data with one another.

FirstWatch™ currently covers a number of geographic areas such as: Fort Wayne, IN; Fort Worth, TX; Johnson County, KS; Kansas City, MO; Las Vegas, NV; Okaloosa County, FL; Oklahoma City, OK; Pinellas County, FL; Plano, TX; Reno, NV; Richmond, VA; San Diego, CA; Sedgwick County, KS; and Tulsa, OK. These areas include approximately 7.5 million people. It has successfully

detected a number of unplanned outbreaks and events including carbon monoxide poisonings from space heater malfunctions, respiratory symptoms following wildfires, heat related illnesses, flu and Norwalk virus.

RedBat™

RedBat™, developed by Infection Control and Prevention Analysts (ICPA), is a dual use syndromic surveillance tool to detect both naturally occurring and planned outbreaks of disease. RedBat™ uses text-mining technology, *SymptomScan*™, to extract symptoms already recorded in the hospital ED (or billing) computer system. Using a large dictionary of terms, RedBat™ automatically converts symptom or chief complaint text into codes that appear in the RedBat™ patient screens. RedBat™ uses the *SyndromicScoringSystem*™ to calculate a syndrome score (between 0-100) using combinations of symptom codes. Scores for 10 possible disease syndromes automatically appear in individual patient records. In addition to a broad array of automated reports, end users can create custom reports. Data can be easily transmitted to the health department via encrypted e-mail to the health department. RedBat™ has successfully detected five naturally occurring outbreaks with only four false positives in one year of surveillance. The vendor describes RedBat™ as highly affordable.

Surveillance, Monitoring and Real-Time Events – SMARTE

SMARTE is a dual use syndromic surveillance system developed by Metatomix to enable communication between government agencies and community based organizations such as hospitals and other health care delivery sites. SMARTE can integrate disparate systems (any format, any location) from across the region or the country to provide a single real-time view of health intelligence data. It can handle all public health monitoring and notification standards including NEDSS, PHIN and HAN and performs epidemiological curve analysis. It provides a secure, HIPAA-compliant, role-based web interface for data entry and information management. It has the capacity to identify and de-identify patient data based on the needs and severity of the current situation. It can process and route HL7 and other standard nomenclature (Snomed, LOINC, CPT4 etc.) and presents data in customizable reporting and visualization formats. It has geo-spatial mapping capability and the ability to integrate meteorological or other environmental information. The integrated rules engine can be used to modify system performance based on the needs of the current situation. In addition, there is an optional collaboration module to provide public health officials with a forum for real time threaded discussions, document sharing, case tracking, scheduling and work flow management.

Rapid Syndrome Validation Project – RSVP

RSVP is an internet-based dual use syndromic surveillance tool developed by Sandia National Labs to facilitate rapid communication between public health officials and health care providers. There are six syndrome complexes in RSVP: influenza-like illness; fever with skin rash; fever with suspect CNS infection; severe diarrhea, adult respiratory distress syndrome; acute hepatitis. These can be modified to track unique health conditions such as SARS, West Nile fever etc. Proprietary algorithms

permit the early detection of disease clusters and trigger automatic notification to public health officials when thresholds are met. It also notifies clinicians regarding what syndromes are reported, where, and with what frequency. Clinicians are also provided with confirmatory lab data and public health advisory notices from the relevant officials.

RSVP provides real-time data reporting, a wide array of GIS analyses and statistical assessments. Confidentiality is protected by using non-specific demographic information for each encounter. The graphical user interface enables clinicians to enter data in less than one minute. RSVP tends to be most heavily used by primary care providers and school nurses. It is in use in over 75 clinics and has detected several influenza outbreaks. The developer describes the system as being inexpensive.

Automated Epidemiologic Geotemporal Integrated Surveillance - AEGIS

AEGIS is a dual use syndromic surveillance system that performs automated, real-time surveillance for bioterrorism as well as naturally occurring outbreaks. AEGIS is the result of collaboration between the Center for Biopreparedness at Children's Hospital in Boston and Harvard Medical School. The goal of this project is to develop a state-wide syndromic surveillance system for the Commonwealth of Massachusetts. Other goals include developing outbreak detection algorithms, mathematical models of disease spread, decision support systems to assist frontline clinicians in the event of a biological attack, as well as robust electronic health information systems to provide clinical care under disaster conditions.

PURPOSE OF THE SYSTEM

We asked respondents to classify the purpose of their systems according to the following categories:

a. Early detection of outbreaks caused by bioterrorism
b. Early detection of infectious disease outbreaks
c. Epidemiological tracking of syndromes during a known outbreak: geographically and temporally
d. Outbreak management
e. Other

All eight systems—AEGIS, WEB Biosurv™, Surveil™, FirstWatch™, RedBat™, SMARTE™, RSVP and Vigilent—covered all four categories. FirstWatch™, which relies principally on data from 911 calls noted its capacity to track and analyze fire and crime patterns. The RedBat™ respondent noted that it could be utilized for the forensic analysis and investigation of an outbreak. The Vigilent™ point of contact noted that it is designed to be a decision support system around an index case, supporting the director of health in marshalling resources around an event.

STAGE OF DEVELOPMENT AND LOCATIONS OF USE

Each system was asked to classify its stage of development according to the following categories:

a. In development
b. Pilot programs
c. Fully operational
d. Other

AEGIS is being piloted at several sites, including Massachusetts Department of Public Health, Children's Hospital Boston, Beth Israel Deaconess Medical Center, Massachusetts General Hospital, and at Brigham and Woman's Hospital.

The remaining systems were classified as fully operational. This includes: WEB Biosurv™, Surveil™, Vigilent™, FirstWatch™, RedBat™, SMARTE™, and RSVP (human version). (The RSVP animal version is in development.)

Table 3: Location of fully operation systems and duration of use.

System	Location(s) of system deployment	Duration of Use
WEB Biosurv™	• Rush Presbyterian St. Luke's Medical Center, Chicago, IL • Illinois Masonic Hospital, Chicago, IL • Christ Hospital, Oak Lawn, IL • Morris Hospital, Morris, IL	> 24 months
Surveil™	• U.S. Department of Veterans Affairs • University of Central Florida Student Health Center	> 24 months < 3 months
Vigilent™	• Florida, Hillsboro County • Barbara Uzenoff, Illinois • Northern Virginia • USAF • Shenandoah Valley Trauma Director and Disaster Director of Winchester Hospital	> 24 months
FirstWatch™	• San Diego, CA • Las Vegas, NV • Reno, NV • Richmond, VA • Pinellas County, FL • Okaloosa County, FL • Fort Worth, TX • Plano, TX • Sedgwick County, KS • Johnson County, KS • Kansas City, MS • Oklahoma City, OK • Tulsa, OK	> 24 months
RedBat™	• Parkland Hospital, Dallas TX • Alaska Regional Hospital, Anchorage AK • San Antonio Health Department, San Antonio TX	6 – 12 months

System	Location(s) of system deployment	Duration of Use
SMARTE™	• Delaware Valley Healthcare Council • University of Texas • Massachusetts Sheriff (Middlesex County) • Massachusetts Emergency Management Agency • NYC Department of Health	> 24 months
RSVP – H (human)	• Lubbuck Public Health Office, Lubbuck TX • Texas Department of Health Region #1 • Public Health Office Humboldt County, CA • Public Health Office San Mateo, CA • Public Health Office Central Massachusetts • Public Health Office of Singapore Ministry	12 – 24 months

PERFORMANCE

We asked respondents to provide documentation of their system's performance in detecting outbreaks, including bio-terrorist scenarios and natural outbreaks. The developers of AEGIS, WEB Biosurv™, Vigilent™, RedBat™, SMARTE™, and RSVP stated that their systems had been formally tested and that positive evaluative reports had been generated (see Appendix C for details). While FirstWatch™ has not been formally tested it has successfully identified a broad spectrum of naturally occurring outbreak and events. These include: carbon monoxide poisonings from space heater malfunctions, respiratory symptoms following wildfires, heat related illnesses, flu and Norwalk virus. The Surveil™ system is being piloted at the University of Central Florida to evaluate its ability to detect outbreaks. This study will evaluate Surveil™ system performance for gold standard reportable conditions (i.e., flu, urinary tract infection). The system will also be tested during a mock biological outbreak.

DUAL-USE

Dual use refers to the capacity of the system to provide reporting, tracking, and other functions relevant to routine public health concerns outside the domain of bioterrorism. All eight respondents indicated that their systems had strong dual use potential.

AEGIS has been used for research management purposes and tracking of asthma.

WEB Biosurv™ has been used to track common outbreaks such as influenza and West Nile virus. It can streamline routine reporting of reportable diseases and conditions and can monitor health of livestock.

Surveil™ describes a broad array of potential uses including: Enhanced Workflow in Primary Care; Emergency Department, urgent care clinic, and physician's office; Biosurveillance; Emerging and

Infectious Disease Surveillance; Cancer Surveillance; Cardiovascular Disease Surveillance; Health Risk Assessment; Clinical Trials Eligibility; Adverse Drug Detection and Reporting

Vigilent™ is designed to aid in incident management. It is rapidly scaleable to a regional and national level during any crisis. Functionality is built around several modules each of which is integrated and can function independently.

FirstWatch™ has been used in a variety of "dual use" functions, which are itemized below:

- Detected increase and geographic clustering of respiratory symptoms during October 2003 wild-fires in San Diego. Extra emergency medical personnel deployed to affected areas; public warnings issued advising residents to remain home with windows closed.
- Detected cluster of CO poisonings in Kansas City, MO (December 2001) traced to space heater malfunctions during cold weather. Public health officials issued warnings to public about safe use of heaters.
- Used on daily basis in Pinellas County, FL for automated notification of drownings/near-drownings for follow-up by county anti-drowning program.
- Detected outbreak of Norwalk virus in senior center in Reno, NV (April 2003).
- Detected pre-season outbreak of flu in Oklahoma City, OK (November 2003).
- Set-up to track heat-related illness in Richmond, VA. Geographic capabilities of system allow officials to determine whether particular neighborhoods or buildings are at risk and take action (i.e. distribute fans, relocate at-risk patients, etc.).

RedBat™ has been used for surveillance of influenza and West Nile virus as well as non-infectious syndromes like injuries or asthma. It can also track and alert the health department when Emergency Department visits increase unexpectedly. RedBat™ claims to reduce time and cost associated with reporting and tracking reportable diseases and conditions through automation of the process.

SMARTE™ is designed for daily use in monitoring and reporting infectious diseases and managing critical events, such as bioterrorism attacks, in real-time. This system has been prototyped and tested in daily use scenarios, natural disasters, and man-made disasters.

RSVP is credited with the early detection of several influenza outbreaks.

SYSTEM COST, TRAINING, AND STAFFING REQUIREMENTS

With the exception of RedBat™ responses to the questions about system cost were vague. Most systems reported that price will vary due to factors such as scope of project, number of servers, population size, average number of 9-1-1 calls per day, number of local health agencies, and number of point-of-care facilities. Respondents encouraged contacting the POC for more specific information relevant to specific needs.

RedBat™ indicates that the local health department version starts at about $10,000 with a yearly support fee of about $725. The point-of-care version starts at about $2,500 with a yearly support fee of about $500.

According to the respondents none of the systems required specialized personnel. Training requirements were also minimal and were noted as one-day for all the systems except RedBat™, which suggested a range of one-day to one-week depending on the applications needed.

DATA INPUTS, MANAGEMENT, AND ANALYSIS

The following table details the data input sources and the medical code sets that the systems use. In addition, the ability of the systems to de-identify and re-identify data is noted in the last two columns. All representatives reported that their systems could both de-identify and re-identify data except for RSVP. In the case of RSVP, a patient could be re-identified if necessary by contacting the clinician or data entry person who recorded the inputs.

Table 4: Data input sources and the medical code sets.

System	Data input sources	Medical code sets employed	De-identify	Re-identify
AEGIS	• Emergency Department data • Chief complaint on presentation • Outpatient/ER discharge diagnosis • Influenza data collected by CDC	LOINC, ICD-9-CM	✓	✓
WEB Biosurv™	• Emergency Department data • Clinic data • Hospital Data • Syndromes presenting to health care providers • Deaths	SNOMED, ICD-9, ICD-10, ICD-9-CM, CPT4	✓	✓
Surveil™	• Emergency Department data Clinic data • Syndromes presenting to health care providers • Other	SNOMED, LOINC, DICOM, MedDRA, ICD-9, ICD-10, ICD-9-CM, CPT4, Other	✓	✓

System	Data input sources	Medical code sets employed	De-identify	Re-identify
Vigilent™	• Emergency Department data • Clinic data • Syndromes presenting to health care providers • Deaths • Veterinary data • Sale of over-the-counter medications • School absences • Other	As a framework we can accept any and all medical code sets.	No answer	No answer
FirstWatch™	• 9-1-1 symptoms • ProQA data • Other	SNOMED, LOINC, DICOM, MedDRA, ICD-9, ICD-10, ICD-9-CM, CPT4, Other	✓	✓
RedBat™	• Emergency Department data • Clinic data • Hospital Data • Syndromes presenting to health care providers	ICD-9, ICD-10, ICD-9-CM	✓	✓
SMARTE™	• Emergency Department data • Clinic data • Hospital Data • Syndromes presenting to health care providers • Deaths • Veterinary data • Sale of over-the counter medications • School absences • Other	SNOMED, LOINC, DICOM, MedDRA, ICD-9, ICD-10, ICD-9-CM, CPT4, Other	✓	✓
RSVP	• Syndromes presenting to health care providers • Veterinary data • Other	LOINC, Other	✓	×

The following table describes whether data is handled manually or automatically. Almost all systems were capable of extracting, receiving and/or translating data from clinical databases and/or non-databases. These systems include the AEGIS, WEB Biosurv™, Vigilent™, FirstWatch™, RedBat™, and SMARTE™ systems. The Surveil™ system cannot utilize data from clinical databases The RSVP system requires manual data entry, though it requires less than one minute. The Vigilent™ point of contact did not provide input for these questions; therefore, the Vigilent™ system is not included in this section.

Table 5: Data entry and analysis.

System	Automated data collection	Automated data transmission to central repository	Automated data transmission to the public health authority	Automated data analysis	Manual data entry and/or analysis REQUIRED	Manual data entry and/or analysis accommodated
AEGIS	✓	✓	✓	✓	×	×
WEB Biosurv™	✓	✓	✓	✓	×	✓
Surveil™	✓	✓	✓	✓	×	×
Vigilent™	✓	✓	✓	✓	×	✓
FirstWatch™	✓	✓	✓	✓	×	×
RedBat™	✓	N/A	✓	✓	×	✓

System	Automated data collection	Automated data transmission to central repository	Automated data transmission to the public health authority	Automated data analysis	Manual data entry and/or analysis REQUIRED	Manual data entry and/or analysis accommodated
SMARTE™	✓	✓	✓	✓	×	✓
RSVP	×	✓	✓	✓	✓	×

The following table details the frequency of system updates, including data, charts, maps, and data analysis. The last column of the table provides information regarding the methods of data analysis. In general, updates and analysis occurs on an hourly basis for the responding systems. RedBat™ provides routine updates and analyses data every 24 hours and can also perform them on demand as needed.

Table 6: Data updates and analysis.

System	Frequency of data updates	Frequency of data analysis	Frequency of chart, tables, and maps being refreshed	Overview of mathematical basis for data analysis
AEGIS	Hourly	Hourly	Hourly	• Temporal models • Artificial Intelligence
WEB Biosurv™	Hourly	Hourly	2-6 Hours	• Statistical probability • Fuzzy logic • Artificial Intelligence • Neural networks
Surveil™	Hourly	Hourly	Hourly	• Artificial Intelligence
LEADERS	Hourly	Hourly	Hourly	• Statistical probability
FirstWatch™	Hourly	Hourly	Hourly	• Temporal models • Statistical probability • General mathematical relationships
RedBat™	24 Hours	24 Hours	24 Hours	• Statistical probability • General mathematical relationships
SMARTE™	Hourly	Hourly	Hourly	• Temporal models • Fuzzy Logic • Artificial Intelligence • Neural Networks • General mathematical relationships • Other
RSVP	Hourly	Hourly	Hourly	• Temporal models • Fuzzy Logic

SYSTEM ALARMS AND REPORTS

The methods of generating alarms are quite varied. An overview of how each of the systems generates an alarm is provided below.

AGEIS triggers alarms when data exceed three-standard deviations from the model predictions for temporal analysis and by employing novel spatial clustering methods.

WEB Biosurv™ sets thresholds and triggers alarms based on data specific to particular hospital patient population, and learns as the hospital population changes.

Surveil™ utilizes a rules-based expert system to determine when specific criteria for alarm conditions are met. The rules are applied on a real-time basis throughout the data collection process. The rules are created and maintained by qualified medical professionals and can be customized to provide alarm thresholds.

Vigilent™ employs predefined bounds set by the end users to render alarms.

FirstWatch™ alarm thresholds are based on a defined number of standard deviations above a mean value calculated from historical values. Thresholds can be customized by the use.

RedBat™ employs automatic thresholds, but users can override these with their own customized threshold algorithms. Automatic thresholds are calculated using a multiple moving average control chart to which a cumulative sum procedure is automatically applied. The alarms are categorized with a color-coded system in which the following alert levels signify increasing levels of risk for an epidemic: Blue (attention), Yellow (caution), Orange (high risk) and Red (extreme risk).

SMARTE™ thresholds are based on a series of applicable rules that define the variables of any given indicator. For example, in tracking infectious diseases, the location, season, and likelihood of occurrence can define a threshold.

RSVP alarm thresholds are set by the local or regional administrator through a secure link from the administrative page, by specifying the number of reports per period of time (day, week, month) for each syndrome.

Below is a tabular overview of alarms and the messaging standards that are utilized by each system.

Table 7: Alarms and messaging.

System	Method of alarm notification	Automatic default for the notification	Messaging Standards
AEGIS	• Visual flag on screen	✓	HL7 v2, XML, Http
WEB Biosurv™	• Visual flag on screen • Email • Pager • Web push	✓	HL7 v2, XML, Http, Flat files
Surveil™	• Visual flag on screen • Email • Pager • Phone	N/A	HL7 v2, XML, Http, Flat Files, Other
Vigilent™	• All methods as desired by end user.	✓	HL7 v2, HL7 v3, XML, Http, Flat files
FirstWatch™	• Visual Flag on screen • Pager • Email • Other	✓	XML, Http, Flat Files, Other
RedBat™	• Visual Flag on screen • Pager • Email • Other	✓	HL7 v2, XML, ASCII Flat files
SMARTE™	• Visual Flag on screen • Pager • Email • Phone • Web Push • Other	✓	HL7 v2, XML, Http, Flat files
RSVP	• Visual Flag on screen • Pager • Email	✓	XML, Http, Other

Routine Reports are generated by the WEB Biosurv™, Surveil™, Vigilent™, FirstWatch™, RedBat™, and SMARTE™ systems. AEGIS and RSVP generate customizable outputs on demand.

SYSTEM FLEXIBILITY

System representatives were asked to comment on system flexibility, i.e. the system's ability to adapt to perceived changes in risk, changing detection needs, and/or changing operating needs. Responses are summarized on the next page.

AEGIS can easily add other nodes and permits modular addition of components to the system. It has the ability to easily change syndrome definitions.

WEB Biosurv™ is flexible in adapting to perceived changes in risk, changing detection needs, and/or operating conditions. The WSARE program detects any variation from the current norms for any analysis.

Surveil™ allows researchers to edit (or create) syndromic and disease rules and then repeat the analysis. This accommodates the investigation of emerging infectious disease, or the inclusion of new symptoms or signs that increase the efficiency of the existing disease rule. Investigators can easily create very specific disease rules to further analyze the data: these rules help define the cause of an outbreak that was detected using the (more sensitive, but less specific) syndromic rules.

Surveil™ also allows triage results data and triage process data to be codified using any number of medical vocabularies. This permits data collected using TriageXpert™ system to be compatible with external systems. Surveil™ may be configured to message raw data, which enables investigators to use external systems that perform additional data analysis (e.g. geographical information systems). The web-based architecture and centralized processing of the Surveil™ system allows Public Health Officials to quickly deploy "drop-in surveillance" at any location. All that is required is a PC and an Internet connection.

Vigilent™ provides full flexibility with manual overrides. In addition, alarms can be reset at will.

FirstWatch™ allows trigger sensitivity to be set and changed by the user. Symptom sets can be customized and changed, as necessary. The historical period used for comparison, i.e. the observation window, can also be customized. FirstWatch™ also works with ProQA, an expanded questioning protocol used by 9-1-1 call-takers. In addition, the FirstWatch™ system architecture allows virtually any field or value in the underlying event database to be added to the detection or filter criteria, which also provides the ability to modify or add new detection algorithms as needed.

RedBat™ has a flexible design that permits almost every surveillance parameter to be changed if necessary. Some changes are considered part of the local customization process and would occur at the initial set-up or during the first 6-months of operation. Other changes may be required to meet new surveillance needs, i.e. changing threshold levels, automatic reports, or new fields. These would be made when necessary by the health agency (same day) or by the developer ICPA (within 48 hours).

SMARTE™ contains two key components relevant to status change. The first is the threshold that alerts key personnel if critical indicators approach or surpass a defined level. Second, the system embeds a rules engine to change the performance or data collection of the system based on the data aggregated, threshold analysis or current situational analysis.
RSVP allows authorized individuals to change data collection fields and alert parameters. Syndromes can be changed, added or deleted as necessary to address perceived risk in the community and the patient population. Also, specific demographics, high-risk groups, symptoms and/or signs can be changed to track changing risk conditions. Likewise, alert/alarm levels (e.g., number of reports over a period of time) can be changed based on the judgment and experience of local or regional public health authorities and the assessment of background and seasonal health conditions in the community.

In addition the capacity to change clinics, personnel, passwords, contact lists/phone numbers, GIS analysis overlays, data display refresh rates, alert sensitivities, map display areas, advisory notices, and data access privileges are all controlled by the local public health office.

CONCLUSION AND NEXT STEPS

Using responses generated by a pilot survey tool we have summarized the key characteristics of eight syndromic surveillance systems. Where possible we have provide summary tables to compare similar kinds of information, in other cases we have provided a brief narrative description. As noted previously, this report does not seek to evaluate these systems nor does it endorse them. It is meant to present a method of collecting and presenting data to assist potential end users in analyzing this domain. We strongly encourage those who use this document to support purchasing decisions to take additional steps:

- Review the individual responses of each developer in Appendix C to obtain more detailed information regarding each system,
- Follow-up with relevant developer POCs for more detailed questions,
- Explore systems not reviewed in this document (see Appendix A for list of other identified systems),
- Use this survey tool as guide to investigate other systems not contained in this report. You may distribute the tool or use it as an interview guide, and
- Contact those who have already installed and used a particular system to get customer feedback. (See locations of installation and POCs in each survey tool).

We strongly encourage those who pursue deeper analysis to share the outcome of that analysis so that we may share it with others. We especially encourage those who are currently using a syndromic surveillance system to share their experience with us. Finally, if you have constructive criticisms that would help us improve the survey tool, the method of presenting data, or the process as a whole please provide comments to us. All communication relevant this process can be sent to: Wil Alvarez, HRSA Project Officer, at walvarez@hrsa.gov.

In this stage of the analysis we were constrained by regulations that limit the scope of pilot survey, which has not been reviewed by OMB. However we view this as an important first step in a process that will evolve over time. We hope you find this helpful and that you will contribute to improving the process and expanding the scope of information in the future.