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An Evaluation of Syndromic Surveillance–Related Practices Among Selected State and Local Health Agencies

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Abstract

Context: Syndromic surveillance consists of the systematic collection and use of near real-time data about health-related events for situational awareness and public health action. As syndromic surveillance programs continue to adopt new technologies and expand, it is valuable to evaluate these syndromic surveillance systems and practices to ensure that they meet public health needs.

Objective: This assessment’s aim is to provide recent information about syndromic surveillance systems and practice characteristics among a group of state and local health departments.

Design/Setting: Information was obtained between November 2017 and June 2018 through a telephone survey using an Office of Management and Budget–approved standardized data collection tool. Participants were syndromic surveillance staff from each of 31 state and local health departments participating in the National Syndromic Surveillance Program funded by the Centers for Disease Control and Prevention. Questions included jurisdictional experience, data sources and analysis systems used, syndromic system data processing characteristics, data quality verification procedures, and surveillance activities conducted with syndromic data.

Measures: Practice-specific information such as types of systems and data sources used for syndromic surveillance, data quality monitoring, and uses of data for public health situational awareness (eg, investigating occurrences of or trends in diseases).

Results: The survey analysis revealed a wide range of experiences with syndromic surveillance. Participants reported the receipt of data daily or more frequently. Emergency department data were the primary data source; however, other data sources are being integrated into these systems.

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All health departments routinely monitored data quality. Syndromes of highest priority across the respondents for health events monitoring were influenza-like illness and drug-related syndromes. However, a wide variety of syndromes were reported as priorities across the health departments.

Conclusion: Overall, syndromic surveillance was relevantly integrated into the public health surveillance infrastructure. The near real-time nature of the data and its flexibility to monitor different types of health-related issues make it especially useful for public health practitioners. Despite these advances, syndromic surveillance capacity, locally and nationally, must continue to evolve and progress should be monitored to ensure that syndromic surveillance systems and data are optimally able to meet jurisdictional needs.

Keywords

biosurveillance; public health practice; public health surveillance; syndromic surveillance

Context

Public health surveillance is the ongoing and systematic collection, analysis, interpretation, and dissemination of data about health-related events for use in public health action.¹ Surveillance serves a variety of public health functions including estimating the impact of disease or injury, detecting disease outbreaks, and informing the development of strategies to reduce morbidity and mortality and to improve health.¹ Syndromic surveillance is a type of public health surveillance that collects and monitors health-related information in near real time.² Use of automated analytic techniques has become a common characteristic of advanced syndromic surveillance systems.³ Syndromic surveillance data collected and used by the National Syndromic Surveillance Program (NSSP) primarily consist of emergency department (ED) visits data (including the patient's chief complaints, diagnoses, demographics, and other patient- and visit-related characteristics; note that personally identifiable information is not collected); however, these systems are flexible and allow for a wide range of data to be used, such as data from other types of health visits. The contribution of syndromic surveillance to strengthen public health situational awareness and to improve capabilities to respond to public health concerns has been recognized previously.^{4,5} This has included the use of syndromic surveillance systems and data to inform emergency response activities, including those related to the opioid crisis, vaping-related lung injury, and the COVID-19 pandemic.⁶⁻⁸

Evaluation of public health surveillance systems is essential; it should include the assessment of system operations, and it should be used to help identify any relevant gaps in performance capacities.^{1,9} A prior survey of syndromic surveillance practice at the state and US territory level found that a vast majority of state public health practitioners (39 of 51 respondents; 80%) routinely access and review data from syndromic surveillance systems.⁹ Specifically, all surveyed syndromic surveillance practitioners monitored ED data and a majority (52%) also monitored poison control center data.⁹ The report did not provide information about whether there are other data sources that practitioners use or would like to use in their syndromic surveillance practice.⁹

Another evaluation, conducted in 2015 by Thomas et al,¹⁰ used qualitative interviews to assess syndromic surveillance systems in 6 state and local health departments. Features of syndromic surveillance examined in that analysis included characteristics of use, utility of various syndromes, utility for early warning and outbreak detection, and assessment of how syndromic data affected daily public health decision making. The analysis found that syndromic surveillance systems had potential to monitor disease outbreaks and provide situational awareness related to planned and unplanned events.¹⁰

To build upon the earlier work by Thomas et al, we surveyed the 31 state and local health departments selected for funding by the Centers for Disease Control and Prevention's (CDC's) NSSP and collected more detailed information about their syndromic surveillance systems and practice. The NSSP is a collaboration between state and local public health agencies, CDC, and other organizations for the development and strengthening of syndromic surveillance systems and practice. As part of these efforts, the CDC provided funding to 27 state health departments and 4 local health departments through a cooperative agreement (more information about the NSSP cooperative agreement is available at <https://www.cdc.gov/nssp/biosense/cooperativeagreement.html>). Our assessment provides current information about syndromic surveillance systems and practice characteristics among the 31 NSSP funding recipients.

Methods

Before developing the survey questions, we conducted a review of available information about state and local health department syndromic surveillance practices and sought input from subject matter experts and program evaluation staff from the Center for Surveillance, Epidemiology, and Laboratory Services.

We used a telephone survey to collect data from senior surveillance staff (eg, principal investigator, project manager, program coordinator, epidemiologist) at each of 31 state and local health departments funded by the CDC to develop and maintain syndromic surveillance systems and practice in their health departments. Only health departments that were funded through the NSSP cooperative agreement were eligible to participate in this study.

The survey consisted of 11 open- and closed-ended questions around key aspects of syndromic surveillance practice including:

- Jurisdictional experience with syndromic surveillance;
- System characteristics including analysis tools and data sources;
- Data processing and data quality practices;
- Data sharing, both within and outside of the jurisdiction;
- Use of syndromes and subsyndromes of importance; and
- Future needs for strengthening syndromic practice.

See Supplemental Digital Content Appendix A (available at <http://links.lww.com/JPHMP/A676>) for the entire survey used. In the context of syndromic surveillance, a syndrome, or subsyndrome, is defined as the occurrence of a cluster of (1) chief complaints, diagnoses, or other information (eg, laboratory test results) related to patient visit.¹¹ The questionnaire was administered over the telephone during monthly meetings CDC project officers held with the recipients as part of their grant management activities. The surveys were completed between November 2017 and June 2018.

Analysis

Using SAS version 9.3 (SAS Institute, Cary, North Carolina; 2012), the collected data were analyzed to generate descriptive statistics, including mean and percent distributions. One question asked health departments to indicate, in order of their priority, the top 5 syndromes they have found valuable for public health decision making. Jurisdictional responses were weighted according to their order of priority, with the top priority receiving the highest weight (5) and the lowest priority receiving the lowest weight (1). The weighted scores assigned to each individual syndrome were then added across all respondents that mentioned it to derive an overall weighted score for each of the mentioned syndromes. These overall weighted scores for the syndromes were then used to generate a treemap visualization where the relative sizes of the boxes associated with the syndromes reflect the differences between their scores (larger box indicates higher score) (Figure). Microsoft Excel (Microsoft Corporation, Seattle, Washington; 2016) was used to generate the treemap.

The data for this study were determined by the CDC's Division of Health Informatics and Surveillance as collected for nonresearch purposes. The data collection was for the purposes of evaluating public health surveillance practices at the jurisdictional level. Therefore, human subjects review did not apply to this project. The collection of the data for this study was approved by the US Office of Management and Budget (OMB no. 0920-0879).

Results

On average, the 31 state and local health departments had 9 years of experience in conducting syndromic surveillance, ranging from 2 to 16 years. Fourteen of the surveyed health departments had more than 10 years of experience, while the remaining health departments (n = 10) had 5 years of experience or less.

All health departments used at least one electronic system (ie, electronic data platform or application) to conduct syndromic surveillance (Table 1). Several health departments used 2 or even 3 systems. The average number of systems used across the 31 health departments was 1.7 (most health departments utilized >1 syndromic surveillance system).

One such data system is the NSSP's BioSense Data Platform, which serves as a data repository, processor, and provisioner of syndromic surveillance data through various applications also hosted on the platform. The most common type of data in the BioSense Data Platform is ED visits data; BioSense also receives data from a number of urgent care centers (UCCs) in the United States. ED data are usually transmitted electronically from EDs to the respective local or state health department and then from the health

departments to BioSense. Users of the NSSP's BioSense Data Platform^{12,13} have access to a cloud-based version of ESSENCE (Electronic Surveillance System for the Early Notification of Community-based Epidemics), an application that enables advanced analysis and visualization of syndromic surveillance data. For example, syndromic surveillance practitioners can use ESSENCE to monitor the data for unusual occurrences of health events (eg, the occurrence of more than an expected number of a certain type of health visits). Almost all survey participants (94%) indicated having access to the ESSENCE application. In addition, 35% indicated the use of a local version or implementation (separate from the NSSP's version) of the ESSENCE application. Ten health departments (32%) used the NSSP's ESSENCE as their only syndromic surveillance application. Locally developed systems were also commonly reported by health departments (23%) in this assessment.

All health departments surveyed noted that they currently use ED data to conduct syndromic surveillance; 23% used only ED data to conduct syndromic surveillance, with the other 77% using at least 2 more data sources. On average, health departments used 3.2 data sources in their syndromic systems. For instance, more than half of health departments (55%) reported the use of UCC data and 32% used reportable disease data. Health departments also mentioned several other data sources, with inpatient data being the most commonly reported (used by 5 health departments). Other data sources included emergency medical services (EMS) (3 health departments), over-the-counter drug sales (3 health departments), and primary care (3 health departments). Almost all health departments (94%) were considering expanding the data used for syndromic surveillance by including poison control centers, EMS, UCCs, and weather data.

Respondents were asked about the periodicity with which syndromic surveillance data are received in their systems (Table 1). A plurality of states (42%) stated that they received data in mostly near real time. About one in 5 health departments (19%) reported that data were received mostly in intervals that were greater than near real time but less than daily batches (ie, more frequent than once a day). The remaining health departments (39%) reported that they received data mostly once a day. No health departments stated that they received most of their data in greater than 24-hour intervals.

All health departments indicated that they routinely monitored data transmission and checked for data flow interruptions (Table 2). Most health departments also routinely checked data completeness at the message and visit level and data timeliness. Thirty-nine percent of health departments indicated other types of data quality checks, in addition to those listed, that did not fit into these categories.

Almost all health departments (90%) reported that they "routinely or often" run queries related to the occurrence of syndromes, subsyndromes, or specific chief complaints (Table 3). A high number of surveyed health departments (84%) also routinely created or monitored alerts that are generated when there is a statistical anomaly or potential event of concern is detected in the data. Most health departments (77%) also often used dashboards for monitoring alerts and other information. Many (68%) routinely investigated potential disease occurrence, trends, or other concerns seen in the data.

To better understand how syndromic surveillance is being used for public health decision making, respondents were asked to list, in order of priority, the top 5 syndromes that have been most valuable to monitor for public health decision making. The weighted scores of the syndromes are reflected in the treemap in the Figure. (See the “Methods” section for explanations about the weighting scheme and presentation of the results in the treemap.) Influenza-like illness and drug-related syndromes received the highest overall weighted scores; however, a wide range of syndromes were mentioned by health departments, including gastrointestinal syndromes, asthma, and weather-related syndromes.

Discussion

Syndromic surveillance is an important tool available to public health for enhanced situational awareness. This is reflected in the use of syndromic surveillance in the COVID-19 pandemic response activities.^{8,14} This also underscores the importance of evaluating and ensuring that syndromic surveillance systems and practices are optimally implemented. The CDC’s “Guidelines for Evaluating Public Health Surveillance Systems”(developed in 1988 with an update in 2001) are used to promote the best use of public health resources through the development of efficient and effective public health surveillance systems.¹ A framework published in 2004 supplemented the existing guidelines for evaluating public health systems and provided further guidance on evaluating a system for early detection for disease-related events, including syndromic surveillance systems.¹⁵ This framework organized important evaluation issues and questions under 3 focus areas: (1) a system description focusing on purpose, stakeholders, and operations; (2) an understanding of outbreak detection capabilities, focusing on data timeliness, validity, and quality; and (3) system experience accrued through system use by public health practitioners, focusing on system utility, flexibility, acceptability, portability, stability, and costs. Our assessment attempted to address several components outlined in this framework. It provides descriptions of jurisdictional systems, outbreak response detection capabilities (specifically regarding timeliness and data quality), and system experience through our analysis of system data use.

The experience of the 31 state and local health departments helps us better understand how syndromic surveillance is being incorporated into public health programs and activities. All respondents indicated that they routinely conducted syndromic surveillance activities.

Our finding that the state and local health departments used syndromic surveillance for a wide range of public health issues is consistent with other studies. Previous reports reflect the broad applicability of syndromic surveillance, including its utility in influenza-like illness monitoring activities^{16,17} and to address opioid and other drug-related public health issues,^{5,18,19,20} which were 2 of the top priorities for the health departments in our survey.

ED data and the NSSP’s ESSENCE application were most commonly used by these health departments. However, most health departments use multiple data sources and rely on both the NSSP’s ESSENCE and local systems to meet their syndromic surveillance needs. Syndromic surveillance activities routinely conducted by the health departments included running queries on health visit-related syndromes and subsyndromes of interest. Monitoring the information using dashboards was common and related to the creation of alerts to detect

health event anomalies. Investigating occurrences of, or trends in, diseases or conditions of concern was also a common practice among respondents.

We anticipated that most, if not all, of the respondents would be using the NSSP's ESSENCE application to conduct syndromic surveillance because respondents were state and local health departments funded by the CDC to enhance their capacity for syndromic surveillance through activities that included participation in the NSSP. It should be noted that state and local health departments worked collaboratively with the CDC to define data access and use rules that meet the needs of federal, state, and local entities. The 2 respondents that did not indicate sending data to the NSSP's platform did not complete the onboarding process (eg, establishing the Internet connections and data transmission and access processes) by the time of our survey. Our findings indicated that many of the respondents used other systems, including locally developed systems, in addition to the NSSP's ESSENCE. These local systems may have provided customized functionality that was not available in the NSSP's ESSENCE.

Because people with urgent and serious medical needs frequently use EDs for care, data from EDs are well suited for conducting syndromic surveillance.^{21,22} Our finding that all of the health departments used ED data is consistent with other reports of syndromic surveillance systems and activities in the United States using ED data.^{18,23–25} However, the reported use of other data sources suggests their potential utility in syndromic surveillance.

Syndromic surveillance capabilities could be further enhanced with diversified data sources. Two previous reports discussed the potential utility of UCC data in syndromic surveillance.^{26,27} Several respondents in our survey indicated they already use UCC data, reportable disease data, and poison control data. Almost all sites mentioned that they would like to include additional data sources in their syndromic analyses. Sites expressed interest in data from poison control centers, EMS, UCCs, and weather data. At the time of the survey, the NSSP's BioSense Data Platform was receiving data from a small number of UCCs and since that time, there has been work in progress to incorporate weather and air quality data (NSSP Program Manager, CDC, email communication, May 21, 2019). Poison control, death, reportable disease, and EMS data are being considered for future inclusion.

Data timeliness and data quality are crucial factors that impact the effectiveness of surveillance systems.^{1,9} All of the health departments in our study received the data mostly at intervals of 24 hour or less. Our assessment did not obtain any data completeness or validity measures associated with the health departments' data. However, we found that all health departments routinely monitored data completeness and data flow integrity.

It should be noted that despite the potential utility of this study, certain limitations remain. Responses to questions are subject to perceptions of the respondent and may not fully represent the actual practices within these organizations. While questions were clarified upon request, respondents could have misinterpreted questions, leading to inaccuracies in their responses. In addition, the participants of our study are not a representative sample of all state and local health departments and therefore the findings of our study may not be generalizable to other state and local health departments across the United States.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Implications for Policy & Practice

- Our findings suggest that syndromic surveillance is becoming well integrated into the public health practice of the state and local health departments we surveyed. Syndromic surveillance is routinely used to monitor and assess health visits and disease occurrence.
- Our findings suggest that syndromic surveillance systems provide timely data and are flexible and applicable for addressing a variety of potential public health threats and issues.
- Increased local and national capacity is needed to ensure that syndromic surveillance systems and data are optimally able to support public health decision making. This should include incorporation of novel data sources and analytic tools, development of data management processes, and emerging technologies. This capacity building also extends to individual’s skills and analytic capabilities and should include additional jurisdictional training to harness the utility of the data.
- Continued efforts are needed to evaluate syndromic surveillance systems and practice. Such evaluations help ensure that syndromic surveillance systems optimally meet public health needs.

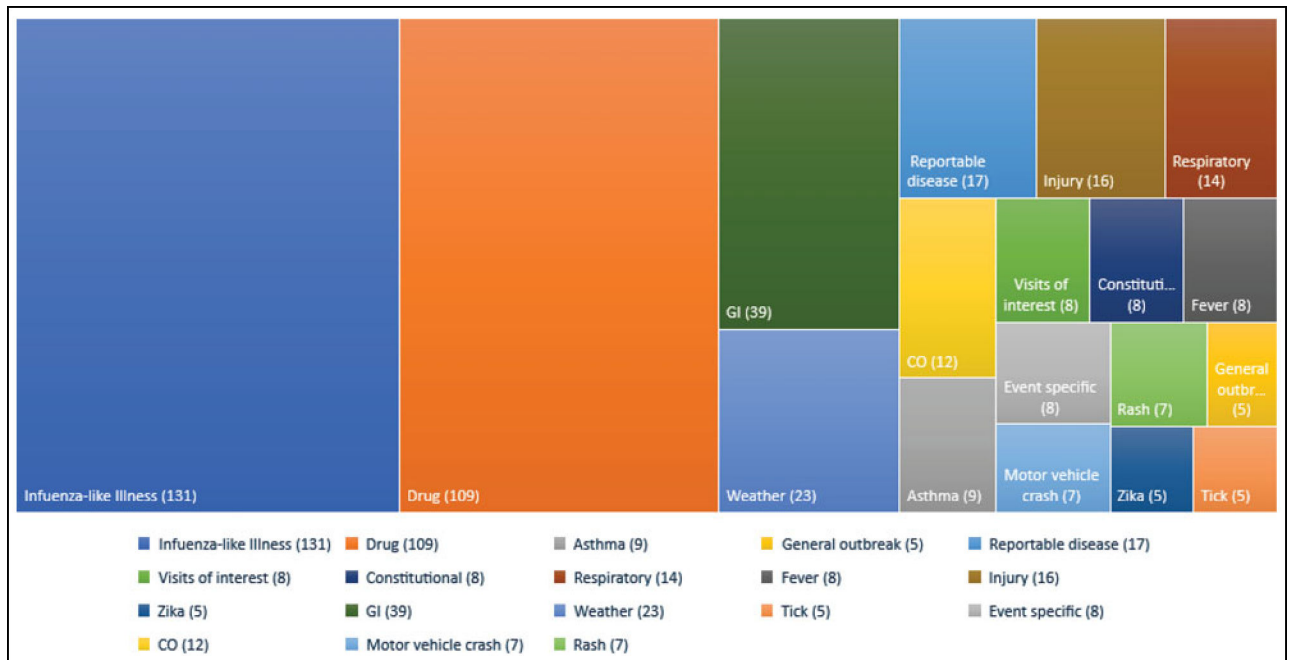


FIGURE. Weighted Scores of the Most Valuable Syndromes for Public Health Decision Making^a
 Abbreviations: CO, Carbon Monoxide; GI, gastrointestinal.
^aNumbers in parenthesis indicate weighted score for each syndrome. This figure is available in color online (www.JPHMP.com).

TABLE 1

Characteristics of Syndromic Surveillance Systems and Data Sources Used by 31 State and Local Health Departments

Characteristic	No. of SLHDs (n = 31)	% of SLHDs (n = 31)
1. Syndromic surveillance systems used by jurisdictions		
NSSP's ESSENCE	29	94
Local essence implementation or version	11	35
Real-time Outbreak Disease Surveillance (RODS)	1	3
EpiCenter	4	13
Locally developed system	7	23
Other system	1	3
Uses at least one system	31	100
2. Data sources used in syndromic surveillance systems		
Emergency department data	31	100
Urgent care center data	17	55
Reportable disease data	10	32
Poison control data	5	16
School attendance data	6	19
Mortality data	6	19
Other data	17	55
3. Jurisdictions would like to incorporate additional data sources into their syndromic systems?		
Yes	29	94
No	2	6
4. Frequency by which syndromic surveillance data are received by jurisdictions		
Mostly in (near) real time	13	42
Mostly in batches of <24 h	6	19
Mostly in daily batches	12	39
Mostly in batches with periodicity of >24 h	0	0

Abbreviations: ESSENCE, Electronic Surveillance System for the Early Notification of Community-based Epidemics; NSSP National Syndromic Surveillance Program; SLHDs, state and local health departments.

TABLE 2

Routine Data Quality Monitoring Practices Among 31 State and Local Health Departments

Data Quality Monitoring Activity	No. of SLHDs That Conduct the Activity (n = 31)	% of SLHDs That Conduct the Activity (n = 31)
Monitoring of data transmission/data interruptions	31	100
Checking message level data quality/completeness	27	87
Checking visit-level data quality/completeness	28	90
Checking visit-level data timeliness	26	84
Other	12	39

Abbreviation: SLHDs, state and local health departments.

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Syndromic Surveillance Activities Conducted by 31 State and Local Health Departments

TABLE 3

Activity	No. (%) of SLHDs That Routinely Conduct the Activity	No. (%) of SLHDs That Sometimes Conduct the Activity	No. (%) of SLHDs That Do Not Conduct the Activity
Monitoring dashboards for alerts and other information	24 (77)	5 (16)	2 (6)
Create and/or monitor health visit–related syndrome or subsyndrome alerts	26 (84)	2 (6)	3 (10)
Run queries on health visit–related syndrome, subsyndrome, or chief complaints information	28 (90)	3 (10)	0 (0)
Share data with other jurisdictions or entities	15 (48)	13 (42)	3 (10)
Investigating occurrences of or trends in diseases or conditions posing a health concern or threat	21 (68)	10 (32)	0 (0)
Downloading batches or pools of data	19 (61)	10 (32)	2 (6)
Create reports based on findings from the data	22 (71)	9 (29)	0 (0)

Abbreviation: SLHDs, state and local health departments.