

Wildfire and Smoke Syndromic Surveillance: An Implementation Guide for Public Health Practice

Council of State and Territorial Epidemiologists (CSTE)

June 2021

This publication was supported by Cooperative Agreement Number NU38OT000297-02-00 from the Centers for Disease Control and Prevention (CDC). The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the CDC.

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The authoring workgroup appreciates the feedback received from the National Syndromic Surveillance Program (NSSP) Community of Practice (CoP) Syndrome Definition Subcommittee members, including practitioners from the Arizona Department of Health Services, Maricopa County Public Health, Massachusetts Department of Public Health, Tennessee Department of Health, and Wisconsin Department of Health Services who ran and tested the novel definitions. The authors would also like to thank the reviewers for their expertise.

Executive Summary

Wildfires are an integral part of many ecosystems; however, in recent years, human behavior and climate change have resulted in wildfire seasons that are longer, more destructive, and more costly. During wildfire events, public health responses most often focus on the health effects of wildfire smoke-related air pollution (i.e., exposure to fine particulate matter [PM_{2.5}]), including exacerbations of respiratory and cardiovascular disease.

Due to the near real-time nature of syndromic surveillance, it can be an effective public health tool for responding to environmental threats like wildfires. However, no standard national syndrome definitions currently exist to enumerate wildfire-related healthcare visits. To strengthen the public health community's ability to track health outcomes of wildfire events, the Council of State and Territorial Epidemiologists (CSTE) Climate, Health, and Equity Subcommittee, in collaboration with the Centers for Disease Control and Prevention's (CDC) Asthma and Community Health Branch, convened a workgroup of local, state, and federal syndromic surveillance practitioners and public health preparedness and environmental epidemiologists to collect and review existing wildfire-related syndrome definitions, develop novel definitions, and disseminate guidance.

Through the collection and review of state and local syndrome definitions, the workgroup developed two novel syndromes in hopes of nationally standardizing syndromic surveillance of wildfire-related visits: **Fire and Smoke Inhalation v1** (formerly wildfire and smoke visits during project period) and **Air Quality-related Respiratory Illness v1** (formerly respiratory visits of interest during project period). Workgroup members from four jurisdictions validated these definitions by using an a priori stepwise approach. Validation centered on known wildfire events, but validators also included pre-and post-fire periods in determining trends. Each validator selected a time period and geography that was appropriate for their data system and local conditions. Daily (i.e., 24-hour) average PM_{2.5} was used as an air pollution validation metric, and correlation between the novel syndrome definitions and daily average PM_{2.5} was assessed.

Overall, the Fire and Smoke Inhalation v1 syndrome definition alerted during known wildfire events, aligned well with daily average PM_{2.5}, showed elevated visits among adults (>18), and most reviewed visits were categorized into respiratory, injury, and other wildfire-related syndromes. The Air Quality-related Respiratory Illness v1 syndrome definition is broad and thus, did not always correlate with PM_{2.5}; however, results improved when the definition was combined with more specific respiratory illness syndrome definitions or the fire and smoke inhalation syndrome definition.

In addition to the novel syndrome definitions, this guide includes case studies illustrating how jurisdictions use wildfire-related syndrome definitions, report on wildfire events, and distinguish smoke-related respiratory visits from pandemic-related respiratory visits during concurrent disasters. The guide also includes options to customize definitions for jurisdictional use, ways to use air pollution monitor data effectively, and best practices for related public health action and trend analysis.

Introduction

Wildfires and Health

Wildfires are “unplanned and uncontrolled fires that originate in wildland areas but sometimes spread to populated areas where they can consume natural and human resources” [1]. From an ecosystem and forestry perspective, wildfires and land management practices such as prescribed burning can be beneficial. They are often necessary to maintain healthy system function and ensure sustained access to ecosystem services for nearby communities [2]. However, wildfires also pose a significant danger to communities and resources [2]. While 85% of wildfires start with human-caused ignitions (intentional and unintentional), 60% of the acres burned in recent years were ignited by

lightning [1]. Wildfire seasons vary by location but typically occur when the landcover is dry, humidity is low, and temperatures and wind are high [1].

In the past two decades, through increasing temperatures, drought, changes in timing and type of winter precipitation, and snowmelt, climate change has contributed to longer wildfire seasons that result in more acres burned [3]. Scientists project these climate trends are likely to continue and, if not addressed, become more extreme. Additionally, wildfire seasons are influenced by human behavior (e.g., through development patterns, forestry management, and prevention and suppression efforts). These activities will lead to an increased accumulation of combustible forest materials [3]. Encroachment of human development on wildlands will be a primary driver of future wildfire risk [4].

Wildfire response is complex and requires collaboration between agencies, including federal, tribal, state, and local entities [2]. According to the National Interagency Fire Center, nearly 59,000 fires burned over 10,100,000 acres of land in the United States in 2020 [5]. Wildfires have many increasing costs (e.g., response and suppression, property loss, community dissolution, loss of ecosystem services). For example, federal suppression efforts have averaged over \$2 billion annually over the past five years [4].

Wildfires pose both direct and indirect health risks—examples include direct exposure to fire and smoke, particularly for firefighters and other first responders; chemical releases following the destruction of industrial, commercial, and residential infrastructure; mental health impacts resulting from evacuation and loss of life, community, natural areas, and property; and air pollution from combustion, which can spread over large geographic areas [5]. While each presents significant risks, public health responses during active wildfires typically focus on the health threats of air pollution.

The pollutant of most concern during a wildfire is fine particulate matter, defined as particulate matter less than or equal to 2.5 micrometers in diameter (PM_{2.5}) [5]. Exposure to elevated PM_{2.5} has short- and long-term health effects, including premature death, acute cardiovascular and respiratory events, reduced respiratory function, chronic disease exacerbation, and eye, nose, throat, and lung irritation [5]. The risk for experiencing health effects of wildfire smoke vary by age and other characteristics [5], including:

- **Children** inhale more air per unit of body weight than adults and are more active outdoors,
- **Older adults** are at an increased risk for underlying conditions and decreased immune system function,
- **Outdoor workers and others spending extended periods outdoors** have increased exposure,
- **People with underlying respiratory and/or cardiovascular conditions** are at risk of disease exacerbation and complications,
- **Pregnant people** are at an increased risk due to physiologic changes and risk to fetal development, and
- **People in marginalized and low-income communities** experience higher rates of environmental injustice, have reduced access to mitigation resources like air conditioning or air filtration, higher baseline exposure to pollutants, and other pre-existing health disparities.

Syndromic Surveillance in Public Health Practice

Syndromic surveillance uses emergency department (ED) visit reports and other pre-existing healthcare or health data for near real-time analysis and detection of patterns and anomalies for public health response [6]. Initially developed to identify bioterrorism threats, the use of syndromic surveillance has since expanded to a multitude of use cases, including to detect changes in visit volume for life-threatening conditions, serve as an early warning for disease outbreaks, monitor vaccine adverse events, and extreme weather conditions, among others. [7] The Centers for Disease Control and Prevention's (CDC) National Syndromic Surveillance Program (NSSP) facilitates collaboration among CDC

subject matter experts and “other federal partners, local and state health departments, and academic and private sector partners” [6]. NSSP supports both the BioSense Platform, which collects state and local electronic health data, and the Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE), an analytic tool within the system. Health departments may use the NSSP BioSense Platform or use stand-alone deployments of ESSENCE or locally developed syndromic surveillance systems for such analyses. Syndromic surveillance uses a syndrome definition (also called a query, syndrome, or grouping) comprised of keywords (chief complaint terms), discharge diagnosis codes, and exclusions to identify records of interest [7]. While this guide should apply to most syndromic surveillance systems, it was designed and developed for NSSP ESSENCE.

Use of syndromic surveillance to monitor environmental health emergencies continues to expand. Jurisdictions rely on syndromic systems to provide rapid information during natural disaster responses and monitor climate- and weather-related health outcomes for several years. To support these efforts, the Council of State and Territorial Epidemiologists (CSTE) has previously convened and supported workgroups developing novel syndrome definitions and guidance for heat-related illness [8] and cold-related illness [9] as well as broader guidance on syndromic surveillance of climate-related health outcomes [10]. Thus, when state and local partners asked CDC climate and health subject matter experts for guidance on wildfire syndromic surveillance during the 2018 and 2019 wildfire seasons, CDC partnered with CSTE to assist.

In 2020, CSTE’s Climate, Health, and Equity Subcommittee convened a workgroup of local, state, and federal syndromic surveillance practitioners and public health preparedness and environmental epidemiologists to 1) collate existing wildfire-related health outcome syndrome definitions; 2) review and summarize syndrome definition commonalities; 3) develop recommended broad, novel wildfire-related syndrome definitions, and 4) develop guidance for jurisdictions to use when preparing for and responding to wildfire events.

Methods

Topic Selection

Workgroup members shared existing syndromic surveillance syndrome definitions used during wildfire and smoke events. As of January 2021, five state and local health departments contributed their definitions (Figure 1). In addition, CDC NSSP staff shared draft definitions. All submitting jurisdictions had existing syndrome definitions for “wildfire” and/or “smoke” as well as various syndrome definitions for health-related outcomes (e.g., respiratory, cardiovascular, eye irritation). In addition, other types of syndrome definitions were shared, including occupational groups (e.g., firefighters, responders) and related events (e.g., evacuation). There was a pre-existing collaboration between some participating jurisdictions, and several jurisdictions used similar definitions. Syndrome definitions submitted by workgroup members were categorized by the following topics: wildfire and smoke, respiratory, cardiovascular, and other.

Workgroup members identified developing a novel fire and smoke inhalation syndrome definition as the top priority. Additionally, based on the experience and expertise of participants, the workgroup also prioritized the development of a novel respiratory illness syndrome definition. The consensus was while the scientific literature supports a correlation between cardiovascular events and air pollution, particularly with extended exposure, syndromic surveillance data has not consistently demonstrated actionable trends during these events. Participants indicated that while they have and

Definitions by Topic

- Fire and Smoke Inhalation: 7
- Respiratory: 13
- Cardiovascular: 7
- Other: 5

Figure 1. Count of Submitted Syndrome Definitions by Topic

will likely continue to monitor cardiovascular outcomes using existing definitions, they primarily rely on wildfire-related syndrome definitions, followed by one or more respiratory illness syndrome definitions when reporting to stakeholders during wildfire and smoke events.

Compilation of Existing Syndrome Definitions

For submitted fire and smoke inhalation and respiratory syndrome definitions, specific inclusion and exclusion terms were compiled. Words, phrases, and codes used in two or more syndrome definitions were added to a reference list of terms. Terms used by only one jurisdiction were evaluated and considered by the workgroup for inclusion/exclusion based on perceived utility. For the respiratory illness syndrome definition, the literature was reviewed to confirm known associations between conditions and wildfire and smoke events [13,14]. The codes from existing syndrome definitions were verified and supplemented with a review of diagnostic coding guides.

The workgroup selected to prioritize codes from the International Classification of Diseases Tenth Revision Clinical Modification (ICD-10-CM) and SNOMED-CT. Given the 2015 transition in the U.S. healthcare system from ICD-9-CM to ICD-10-CM, codes from the International Classification of Diseases Ninth Revision Clinical Modification (ICD-9-CM) were not included in the workgroup's developed, novel syndrome definitions. The workgroup concluded that retrospective analysis of syndromic data would be a low priority for jurisdictions when systems are continually evolving.

While the majority of NSSP records include only ICD-10-CM codes (79% in 2020), alternative versions of the syndrome definitions, including ICD-9 and SNOMED equivalents, were developed by CDC subject matter experts (SMEs) for states using these codes ([see Appendix C](#)). [12] The alternative syndrome definitions are those available to NSSP BioSense Platform ESSENCE users.

Case Study: Prior Wildfire Syndromic Surveillance Efforts Helped Focus Proposed Definition Scope

In 2019, a substantial wildfire called the "Swan Lake Fire" burned between Anchorage and Soldotna, Alaska. The fire burned with varying intensity for several months, impacting air quality on the Kenai Peninsula and Anchorage. Additionally, during August, there was wildfire activity in the Willow area north of Wasilla, Alaska, which also impacted the Anchorage area. To assess the impact of these fires, a year of syndromic data [September 30, 2018 (week 40 start) - October 5, 2019 (week 40 end)] were reviewed, at the weekly level, to assess correlations between PM_{2.5} and ED visits for several potentially related health outcomes and indicators. Associations were observed visually at the regional level using the nearest air pollution monitor. Elevated PM_{2.5} was recorded during the winter (last week of October to the third week of January) and weeks of high wildfire activity during the summer months (late June/early July). The most evident correlation was between a syndrome definition looking for smoke-related keywords and PM_{2.5} in the South Central region (Figure 2). The asthma syndrome definition illustrated a correlation with PM_{2.5} during the winter but remained within the expected range. During summer fires, asthma visits were observed at higher-than-expected levels (i.e., ESSENCE alerts and warnings). Syndrome definitions for chronic obstructive pulmonary disease (COPD) and broad respiratory and cardiovascular visits did not appear correlated with fire-related increases in PM_{2.5}.

Figure 2. Alaska's Wildfire Smoke Syndrome Definition and PM_{2.5}, Alaska South Central Region, 2018-2019.

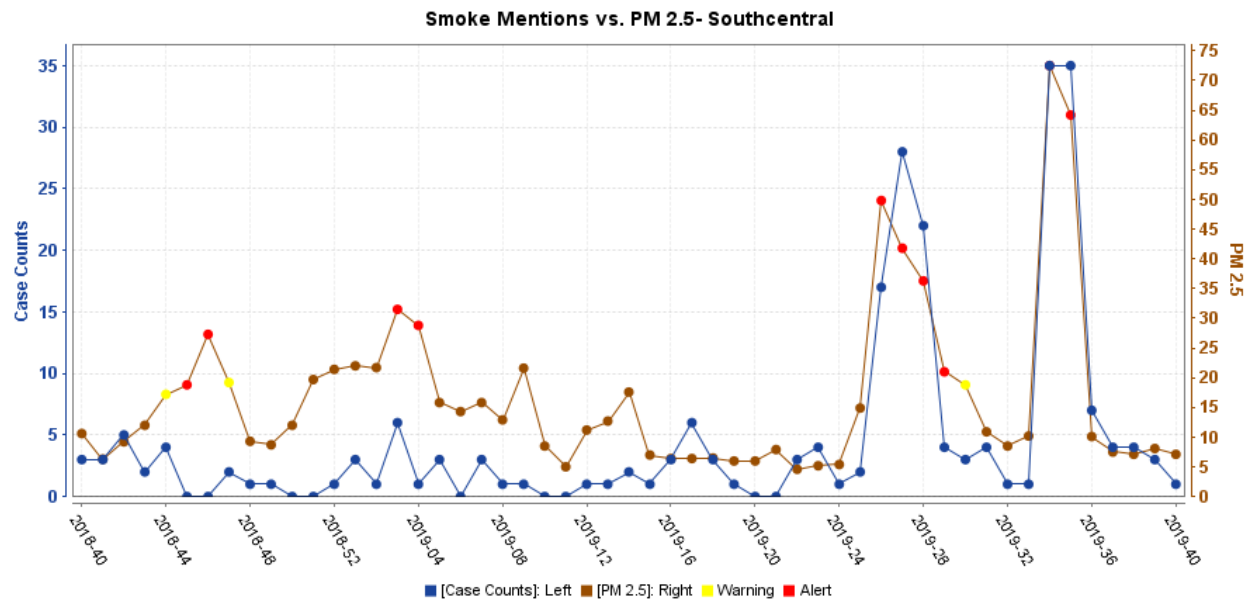


Figure 2: The blue line represents ED visits matching the wildfire smoke syndrome definition, and the brown line represents PM_{2.5} observed at an air pollution monitor. ESSENCE-generated warnings (yellow, p-value <=0.05) and alerts (red, p-value <= 0.1) are shown for both ED visits and air pollution.

Novel Syndrome Definitions

Fire and Smoke Inhalation Syndrome Definition

The fire and smoke inhalation syndrome definition is based on existing definitions from six jurisdictions and agencies (five state and local health departments and NSSP). The syndrome definition comprises alphanumeric inclusion codes from the diagnosis field; inclusion terms from the chief complaint field, sometimes with term-specific exclusions; and universal exclusion terms from the chief complaint field (Table 1). Both ICD-10-CM and SNOMED-CT diagnosis codes are included. Exclusion terms should be also included.

Table 1. Inclusion and Exclusion Terms for the Fire and Smoke Inhalation Syndrome Definition

Category	Terms to Include in Syndrome Definition		Status
ICD-10-CM Diagnosis Codes	J70.5	Respiratory conditions due to smoke inhalation	Included codes
	X08.8	Exposure to other specified smoke, fire, and flames	
	T59.81	Toxic effect of smoke	
	X01.1	Exposure to smoke in uncontrolled fire, not in building or structure	
SNOMED-CT Diagnosis Codes	423123007	Smoke inhalation injury (disorder)	
	"wildfire"		Included term

Chief Complaint Search Terms	"wild fire"	Included term
	"smoke " ANDNOT (" a smoke",or," to smoke",or,"alarm",or,"can smoke",or,"denies smoke",or,"detector",or,"did smoke",or,"does not smoke",or,"does smoke",or,"go and smoke",or,"go smoke",or,"he smoke",or,"husband smoke",or,"n_t smoke",or,"never smoke",or,"no smoke",or,"or smoke",or,"out and smoke",or,"outside and smoke",or,"secondhand",or,"second hand",or,"smoke bomb",or,"smoke shop",or,"smoke week",or,"smoke[drs]",or,"smoke"a lot",or,"they smoke",or,"upstairs and smoke",or,"was smoking",or,"wife smoke",or,"without smoke",or,"blunt",or,"joint")	Included term with specific exclusions
	"canab",or,"cannab",or,"cig",or,"crack",or,"her[io][oi]n",or," k2 ",or,"marij",or,!meth!,or,!pot!,or,"spice",or,"tobac",or,"weed"	Drug-related universal exclusion terms
	"normal saline",or," on fire",or,"cooking",or,"kitchen",or," stove ",or" oven ",or,"motor [bc]",or,"motor[bc]",or,("motor vehicle",and,("collision",or,"accident",or,"crash"))	Other universal exclusion terms

ESSENCE Syntax: Fire and Smoke Inhalation

To facilitate use by jurisdictions with ESSENCE systems, below is an example of the syndrome definition in ESSENCE syntax. This syntax includes formatting of diagnosis codes with and without decimals (i.e., periods) where applicable. Delimiters before diagnosis codes may be a semicolon (;), a slash (/), or space. If the system uses different delimiters, an adjustment will be necessary.

```
(,^[;/ ]J70.5^,or,^[;/ ]J705^,or,^[;/ ]X08.8^,or,^[;/ ]X088^,or,^[;/ ]X01.1^,or,^[;/ ]X011^,or,^[;/ ]T59.81^,or,^[;/ ]T5981^,or,^[;/ ]423123007^,or,^wild fire^,or,^wildfire^,or,(,^smoke ^,andnot,(,^ a smoke^,or,^ to smoke^,or,^alarm^,or,^can smoke^,or,^denies smoke^,or,^detector^,or,^did smoke^,or,^does not smoke^,or,^does smoke^,or,^go and smoke^,or,^go smoke^,or,^he smoke^,or,^husband smoke^,or,^n_t smoke^,or,^never smoke^,or,^no smoke^,or,^or smoke^,or,^out and smoke^,or,^outside and smoke^,or,^secondhand^,or,^second hand^,or,^smoke bomb^,or,^smoke shop^,or,^smoke week^,or,^smoke[drs]^,or,^smoke^a lot^,or,^they smoke^,or,^upstairs and smoke^,or,^was smoking^,or,^wife smoke^,or,^without smoke^,or,^blunt^,or,^joint^,),),),andnot,(,^canab^,or,^cannab^,or,^cig^,or,^crack^,or,^her[io][oi]n^,or,^ k2 ^,or,^marij^,or,!meth!,or,!pot!,or,^spice^,or,^tobac^,or,^weed^,or,^normal saline^,or,^ on fire^,or,^cooking^,or,^kitchen^,or,^ stove ^,or,^ oven ^,or,^motor [bc]^,or,^motor[bc]^,or,(,^motor vehicle^,and,(,^collision^,or,^accident^,or,^crash^,),),)
```

Note: This definition is limited to ICD-10 codes and a single SNOMED code. CDC SMEs made modifications to include equivalent ICD-9 and additional SNOMED codes in the final ESSENCE syndrome definition labelled Fire and Smoke Inhalation v1, to accommodate variations in diagnosis code types shared by state and local jurisdictions and enhance utility of the query within those jurisdictions. Additional chief complaint terms commonly associated with the included diagnosis codes were also added.

Air Quality-related Respiratory Illness Syndrome Definition

The air quality-related respiratory illness syndrome definition is based on existing definitions from three state and local health departments. The syndrome definition comprises alphanumeric inclusion codes from the diagnosis field; inclusion terms from the chief complaint field, sometimes with

term-specific exclusions; and universal exclusion terms from the discharge diagnosis and chief complaint fields (Table 2). Only ICD-10-CM diagnosis codes are included. Exclusion terms are also included.

Of those submitted for the project, the largest number of syndrome definitions related to respiratory illness. Many jurisdictions had both broad and narrow syndrome definitions. This is a broad syndrome definition comprised of specific respiratory conditions associated with wildfire and smoke events. Unlike many syndrome definitions, it is organized by the condition—diagnosis codes then search terms—so syndromic surveillance practitioners can customize the syndrome definition by adding, removing, or separating conditions as they need. For more on this, see [Adjustment for Jurisdictional Use](#).

Table 2. Inclusion and Exclusion Terms for the Air Quality-related Respiratory Illness Syndrome Definition

Category	Terms to Include in Syndrome Definition		Status
ICD-10-CM Diagnosis Codes	J20	Acute bronchitis	Included code
Chief Complaint Search Term	"acute bronchitis"		Included term
ICD-10-CM Diagnosis Codes	J43	Emphysema	Included code
Chief Complaint Search Term	"emphysema"		Included term
ICD-10-CM Diagnosis Codes	J44	Other chronic obstructive pulmonary disease	Included code
Chief Complaint Search Terms	" COPD",or,"chronic obstructive airway disease",or,"chronic obstructive lung disease",or,"chronic obstructive pulmonary disease"		Included terms
ICD-10-CM Diagnosis Codes	J45	Asthma	Included code
Chief Complaint Search Terms	"asthma",or,"bronchasthma",or," RAD ",or,"reactive airway disease"		Included terms
ICD-10-CM Diagnosis Codes	J80	Acute respiratory distress syndrome	Included code
Chief Complaint Search Terms	"difficulty breath",or,"breathing problem",or,"chest tightness",or,"chronic cough"		Included terms
ICD-10-CM Diagnosis Codes	R06.0	Dyspnea	Included codes
	R06.02	Shortness of breath	
Chief Complaint Search Terms	"dyspnea",or,"shortness of breath",or," SOB "		Included terms

Chief Complaint Search Terms	"wheeze" ANDNOT ("cough",or,"cold",or,"congestion")		Included term with specific exclusions
ICD-10-CM Diagnosis Codes	R50.9	Fever, unspecified	Universal exclusion code
Chief Complaint Search Terms	febrile",or,"fever",or,"high temp"		Universal exclusion term

ESSENCE Syntax: Air Quality-related Respiratory Illness

An example of the syndrome definition in ESSENCE syntax is included below to facilitate use by jurisdictions with ESSENCE systems. This syntax includes formatting of diagnosis codes with and without decimals (i.e., periods) where applicable. Delimiters before diagnosis codes may be a semicolon (;), a slash (/), or space. If the system uses different delimiters, adjustment is needed.

```
(,^[;/ ]J20^,or,^acute bronchitis^,or,^[;/ ]J43^,or,^emphysema^,or,^[;/ ]J44^,or,^COPD^,or,^chronic obstructive airway disease^,or,^chronic obstructive lung disease^,or,^chronic obstructive pulmonary disease^,or,^[;/ ]J45^,or,^asthma^,or,^bronchasthma^,or,^RAD^,or,^reactive airway disease^,or,^[;/ ]J80^,or,^difficulty breath^,or,^breathing problem^,or,^chest tightness^,or,^chronic cough^,or,^[;/ ]R06.0 ^,or,^[;/ ]R060 ^,or,^[;/ ]R06.02^,or,^[;/ ]R0602^,or,^dyspnea^,or,^shortness of breath^,or,^ SOB^,or,^(,^wheeze^,andnot,(,^cough^,or,^cold^,or,^congestion^,)),andnot,(,^[;/ ]R50.9^,or,^[;/ ]R509^,or,^febrile^,or,^fever^,or,^high temp^,),)
```

Note: This definition is limited to ICD-10 codes. CDC SMEs made modifications to include equivalent ICD-9 and SNOMED codes in the final ESSENCE syndrome definition labelled Air Quality-related Respiratory Illness v1, to accommodate variations in diagnosis code types shared by state and local jurisdictions and enhance utility of the query within those jurisdictions. Additional chief complaint terms commonly associated with the included diagnosis codes were also added.

Modified Queries

Please see [Appendix C](#) for final ESSENCE syndrome definition syntax for both wildfire-related syndrome definitions.

Validation

Process

There are a variety of methods available to validate syndromic surveillance syndrome definitions [8,9,10,11]. Some methods are highly labor-intensive, such as medical chart review [8,9]. Others may be prohibited by local syndromic data use agreements, such as matching syndromic records to final hospital discharge and ED data [8,9]. Review of syndromic data for internal consistency is a type of validation frequently done. For example, for syndrome definitions highly reliant on chief complaints (such as the novel wildfire and smoke syndrome definition), one could conduct a manual review, label each visit record as either probable, ruled out, or undetermined, and then calculate percent probable for each term [8]. For syndrome definitions that include equivalent chief complaint terms and discharge diagnosis codes, internal validation could involve calculating the percent positive value, sensitivity, and specificity of chief complaint terms compared to discharge diagnosis codes [9].

The study of wildfire and smoke presented another option for validation: correlation of syndrome definition trends to air pollution data, an external indicator of the severity of wildfire smoke

in a particular location. As monitored air pollution data are integrated into ESSENCE and often used during wildfire and smoke events, this method of external correlation was preferred by CDC SMEs advising on this project. Workgroup members were asked to volunteer to validate the novel syndrome definitions. Validators were provided with a template for reporting results (see [Appendix A: Validation Template](#)) and a detailed guide (see [Appendix B: Validation Guide](#)). While the template and guide are specific to this project, the model of providing required and optional steps and systematically collecting feedback could be used to standardize the validation process for other syndrome definitions. Four state and local health departments submitted their results during the project period. Additionally, NSSP partners ran one iteration of their internal text mining report to provide additional insights on the syndrome definition performance at a national scale (see [NSSP Text Mining Reports](#)).

Results

The novel Fire and Smoke Inhalation v1 definition performed well in both large and small areas and populations. There were statistically significant increases in visits above what would be expected during known wildfire events, which tended to rise quickly over several days at the start of the event, plateau, and then decrease quickly. There were few visits and few days or weeks where visits were statistically higher than expected outside of wildfire season. During known wildfire events, more visits than expected occurred among adults aged 18-44 and 44-64 years. When examining the visits by ESSENCE syndrome, the visits were categorized into the respiratory, injury, and sometimes the other categories, which aligns with the scientific literature. The Fire and Smoke Inhalation v1 definition was correlated with monitored PM_{2.5} from a station near the fire or with the jurisdiction-wide maximum daily average PM_{2.5} in cases where the entire jurisdiction was impacted.

Feedback from validators resulted in improvements to the Fire and Smoke Inhalation v1 definition. The “ash” inclusion term and exclusions were removed from the syndrome definition, as this section was of little value to the validating jurisdictions. This syntax, however, was retained as an option in the [Customizing the Novel Syndrome Definition for Wildfire and Smoke Visits](#) section. Several additional exclusion terms were added, including “secondhand” to the “smoke” term and additional general kitchen exclusions of “stove” and “oven” to remove smoke and fire visits related to kitchen fires as opposed to wildfires.

The novel Air Quality-related Respiratory Illness v1 definition is broad. While some jurisdictions observed clear trends during wildfire events, some did not. The correlation between the syndrome definition and PM_{2.5} was most evident when the daily average PM_{2.5} was elevated above 150 µg/m³ or higher (i.e., Air Quality Index of “Very Unhealthy” or higher) [15]. Validators noted the large volume of visits matching this syndrome definition. They hypothesized that the increase in visits related to the wildfire was not detectable given the broad nature of the syndrome definition when air pollution was not severely elevated. Workgroup members suggested pairing this syndrome definition with more specific respiratory syndrome definitions to be more actionable or combining both novel syndrome definitions. See more in the [Customizing the Novel Syndrome Definition for Respiratory Visits of Interest](#) section.

Limitations

Generalizability

It is important to be mindful that the developed definitions are broad in nature, thus they are likely capturing visits not limited to the intent of the queries. For example, wildfire query may return visits not related to uncontrolled burns or wildfires. Similarly, the respiratory definition is not limited by

any wildfire terms. Subsequently, the query returns all visits meeting the respiratory qualifiers and the trend should not be interpreted as being solely related to wildfires.

Project Timing

The workgroup convened in October 2020 and met monthly between November 2020 and April 2021 and comprised of federal, state, and local syndromic surveillance practitioners and public health preparedness and environmental epidemiologists, many of whom were responding to the COVID-19 pandemic. Additionally, several members were responding to concurrent natural disasters. While members' participation was active (monthly webinars had at least 10 participants), the ongoing circumstances limited participation by other potential workgroup members. Requests made of participating members were intentionally as specific and limited as possible due to the known competing demands on time and resources.

Data Source Considerations

The developed novel definitions were validated using ED visit data. One jurisdiction also included visits from inpatient and outpatient facilities. Previously existing syndrome definitions contributed to this project were primarily developed and used with ED visit data. Some participating jurisdictions also developed and used previously existing syndrome definitions with inpatient, outpatient, and other data sources. Workgroup members were aware that other data sources could be used for wildfire and smoke surveillance in the future, particularly EMS or 911 call data. While it is unknown how many jurisdictions have this data source integrated into their syndromic surveillance systems, less than 1% of all recent NSSP visits have mentions of “EMS” or “911” in the chief complaint discharge diagnosis (CC/DD) field at the time of this report [16]. ESSENCE users queried the CC/DD field. If these syndrome definitions are used with other data sources or fields, the user should be aware that they were not tested or validated on such data sources.

Geographic Considerations

While wildfires are a hazard throughout the United States, they most commonly affect and impact the Western states. Consequently, most of the public health wildfire surveillance experience and expertise is concentrated in Western jurisdictions. The federal, state, and local syndromic surveillance practitioners and public health preparedness and environmental epidemiologists invited to participate in this project were geographically diverse, but jurisdictions that shared pre-existing syndrome definitions and validated the novel syndrome definitions were mainly from the Pacific Coast. The rest were from the Southeast. Additionally, members of the NSSP Community of Practice (CoP) Syndrome Definition Subcommittee from the Midwest, Northeast, Southeast, and Southwest United States ran and tested the novel definitions and provided feedback. Their suggestions are included in the [Adjustment of Jurisdiction Use](#) section. It is important to note that while the novel syndrome definitions are intended to be used broadly, syndromic surveillance practitioners should consider local conditions and include modifications that are unique to their region when using these novel syndrome definitions.

Adjustment for Jurisdictional Use

Customizing the Novel Syndrome Definition for Fire and Smoke Inhalation

One jurisdiction included “air pollution” and “ash” terms in their pre-existing wildfire and smoke syndrome definition. These terms were unique. If a patient presented to the ED and air pollution was the medical concern, members hypothesized patients might use colloquial terms such as “haze” or “bad air,” which are not included in the pre-existing definition. Workgroup members selected not to include an “air pollution” term in the novel definition as there can be non-wildfire air pollution events. The wildfire and smoke syndrome definition included “ash.” However, this was removed as validators found

few and unrelated cases. Both options are provided below in Table 3 as an example of how jurisdictions may customize the wildfire and smoke syndrome definitions for their area of study.

It is important to note that the definition is intended to be narrow. If significant numbers of cases are being captured during non-wildfire events or if the chief complaints are not related to wildfires, additional modifications may need to be made (Table 3). If visits related to the house or other structure fires are present, additional exclusions can be added. There are also two codes (i.e., Y920 and X00.1) that some providers or systems may use to indicate a residential location for the injury or event. These can also be excluded. Finally, while the “smoke” term includes numerous exclusions, and the definition includes additional universal “drug” exclusions, these are not comprehensive. Additional substances may be added individually, or ESSENCE users may find it easier to excluded all visits meeting the definition of the CDC All Drug CC/DD Category.

Table 3. Potential Inclusion and Exclusion Terms for the Wildfire and Smoke Visits Syndrome Definition

Category	Terms to Include in Syndrome Definition		Status
Chief Complaint Search Terms	"air pollut"		Included term
	" ash" ANDNOT ("dr ash",or,"pcp ash",or,"ash wed",or,"ash cath",or,"tray")		Included term with example exclusions
	ANDNOT ("home fire",or,"house fire",or,"apartment fire",or,"apt fire",or,"building fire",or,"fire at home",or,"fire at apartment",or,"electric fire",or,"electrical fire",or,"indoor fire")		Example excluded terms
ICD-10-CM Diagnosis Codes	Y920	Non-institutional (private) residence as the place of occurrence of the external cause	Exclusion code
	X00.1	Exposure to smoke in uncontrolled fire in building or structure	Exclusion code
ESSENCE CC/DD Category	CDC All Drug Definition		Exclusion category

Customizing the Novel Syndrome Definition for Air Quality-related Respiratory Illness

The novel Air Quality-related Respiratory Illness v1 definition presented in this document is broad. It did not strongly correlate with air pollution or alert to more visits than statistically expected during known wildfire events in all jurisdictions during the validation process. The novel syndrome definition is intentionally organized by the condition—diagnosis codes then search terms—so that users can customize the syndrome definition by adding, removing, or separating conditions to meet their needs best. For example, this novel syndrome definition could be combined with other locally- or community-developed respiratory syndrome definitions or ESSENCE subsyndromes. In addition, a user could separate the conditions to monitor asthma, acute bronchitis, and COPD visits separately using the

included terms and codes with the universal exclusions for each. Finally, one could combine both novel syndrome definitions to identify wildfire-related respiratory visits best.

It is important to note that the health outcomes of interest were selected because of their associations with wildfire smoke exposure, which is primarily PM_{2.5}. This definition could be used during other times of elevated fine particulate matter air pollution from non-wildfire sources.

Using Air Pollution Monitor Data Effectively

The 'Air Quality Data' data source in ESSENCE includes monitored air pollution observations. Of the available metrics, the daily (i.e., 24-hour) average of PM_{2.5} is most relevant to wildfire and smoke events [6]. This pollutant is inhalable particles, 2.5 microns or less in diameter, resulting from the combustion of organic material including fossil fuels and smoke from wildfires [6]. The data in ESSENCE are provided by the Environmental Protection Agency's (EPA) AirNow Program [17]. Monitors are placed for regulatory purposes, not for public health surveillance. Additionally, ESSENCE users do not directly control this data source, and outages or data errors are not directly correctable.

Selecting an air pollution monitor for wildfire surveillance can be difficult. For instance, if a jurisdiction is experiencing a smoke event, one may select the state or county aggregation function in ESSENCE to obtain the jurisdiction-wide maximum daily average PM_{2.5} for the duration of the event. Alternatively, one can select specific monitors. It is advisable to select the monitor located closest to the population of concern rather than closest to the fire [17]. When working with stakeholders and reporting syndromic surveillance findings, one may also consider referencing air pollution reporting from other sources, such as the Air Quality Index values reported by local officials.

Recommended Next Steps

NSSP Text Mining Reports

NSSP staff created internal Text Mining Reports using the Chief Complaint Query Validation (CCQV) data source in NSSP ESSENCE. This large dataset was created for testing and validating new syndrome definitions. It includes the chief complaint and discharge diagnosis fields but does not include facility or patient demographic information. Some sites have opted out of contributing their data to the CCQV data source. During the validation process, a text mining report was run for both novel syndrome definitions (Figure 3). These reports provided valuable information about the performance of the syndrome definitions at the national and regional levels. Additional iterations and text mining could be done to refine these and future novel syndrome definitions.

Figure 3. Chief Complaint Term Co-occurrence Network Graph for Novel Wildfire and Smoke Visits Syndrome Definition from NSSP Text Mining Report

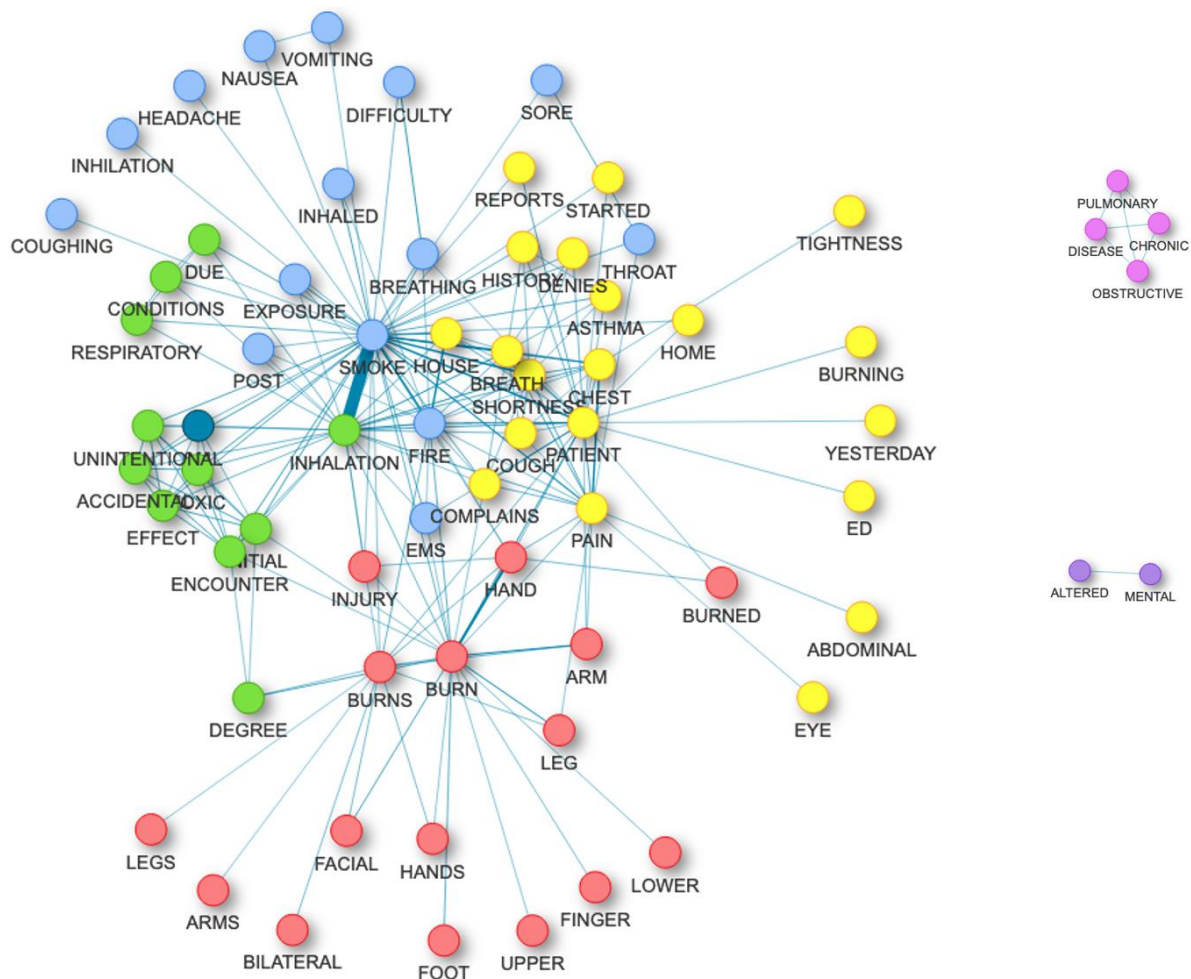


Figure 3. The thick line between “smoke” and “inhalation” indicates the high occurrence and association of these terms. Colored groupings indicate term clusters; for example, red terms are related to burns and burn locations.

NSSP Community of Practice (CoP) Syndrome Definition Subcommittee

The NSSP Community of Practice (CoP) connects syndromic surveillance users to practice further and fosters collaboration [18]. Members engage in work through topic-specific subcommittees. The Syndrome Definition Subcommittee “creates, evaluates, and refines syndrome definitions, links users with similar syndrome definition needs, and documents these processes. Acting as a collaboration resource, the group shares and discusses syndrome definition creation best practices” [19]. This group hosts monthly calls (on the 1st Wednesday of the month from 1:00-2:00 pm ET) open to all NSSP CoP members. This subcommittee is a forum for further validation and adoption of new syndrome definitions. New syndrome definitions can be shared via the Knowledge Repository (<https://knowledgerepository.syndromicsurveillance.org>) and can, with subcommittee approval, be incorporated into NSSP ESSENCE as CC/DD Categories. For more information, visit the NSSP CoP website (nsspcommunityofpractice.org).

Best Practices

How to Use Syndrome Definitions for Public Health Action

Workgroup members strongly recommended preparing a wildfire dashboard or myESSENCE tab in advance of wildfire season [20]. Collecting the core wildfire and smoke syndrome definition with health outcome syndrome definitions and demographics of interest can provide a baseline for reporting during fire and smoke events. Possible syndrome definitions to include, but are not limited to, novel syndrome definition for wildfire and smoke visits, novel syndrome definition for respiratory visits of interest, disaster-related mental health v1 definition [21], other more specific respiratory, cardiovascular¹, and occupational definitions. These health-related definitions can be stratified by age group. PM_{2.5} should be included, either as an overlay on the health-related data or as a separate graph. In many cases, one user can create the dashboard and share it with others within their department and with other departments (e.g., state sharing with local health departments) for use and customization.

Establishing a plan for using syndromic surveillance during a wildfire event also requires collaboration with critical partners. Depending on a department's organization, there may be internal stakeholders, such as risk communication experts, a preparedness and response incident command team, or environmental health staff interested in syndromic surveillance data and findings. Additionally, there may be external stakeholders (e.g., staff at other state or local agencies) that may use syndromic reports. While these partners may not be syndromic surveillance users, they may have input on what type of information would be beneficial to their response efforts, which could affect reporting parameters, including the syndrome definitions monitored, geography, and time scale for reports. It is vital to educate any partners using syndromic surveillance findings of the strengths and limitations of the data source, in general, and for wildfire surveillance. For example, it is important to know what type of facilities report (e.g., ED, hospital, urgent care), where those facilities are located in relation to population centers and wildfire zones, the frequency of data updates (e.g., 15-min, hourly, daily), weekly trends in visit volumes (e.g., some facilities do not report on weekends), the fields that are routinely submitted (e.g., chief complaint, discharge diagnosis, triage notes), and if data submitters are agile enough to tag visits connected with the event with keywords specified by the health department. These factors influence the type, frequency, and utility of reporting that may be possible with syndromic data. This education is best done before an event so that expectations, roles, and responsibilities are established.

Case Study: Repurposing Existing Syndromic Surveillance Report to Summarize Wildfire Season

During normal operations, Oregon ESSENCE publishes regular reports on seasonal hazards, such as heat-related illness visits during the summer and carbon monoxide exposure visits during the winter. The team initially invested the time to create a report template for the seasonal hazards using the ESSENCE report feature and modifying the specific syndrome definitions and any supporting text at the beginning of each season. Weekly time series graphs show statewide trends, and syndrome definitions are described and shared so local health departments can replicate them as needed. The report is distributed via a network of subscribers, and the most recent one is posted on their website.

At the end of September 2020, the team published a report using the template and customized it with a summary of the wildfire season, Oregon climate change and wildfire information, links to relevant risk communication, and air pollution monitoring resources. Findings were placed in the context of all ED and asthma-related visits, which had remained at normal levels all season. Wildfire-

¹ Workgroup members reported that they are frequently asked to monitor cardiovascular outcomes during wildfire and smoke events, but because of the short-term nature of many exposure events and the nature of syndromic surveillance, significant increases in visits are rarely seen.

related visits were higher than expected in early August (Figure 4), and smoke-related visits rose during early September (Figure 5). Visits for both wildfire and smoke-related complaints peaked during the week ending September 19 (week 2020-38). Unlike other jurisdictions, Oregon queries for these terms separately, and the report highlights that wildfire terms alone may be a leading indicator in that state.

Figure 4. Oregon's Wildfire-related Visits Syndrome Definition, Oregon, 2020.

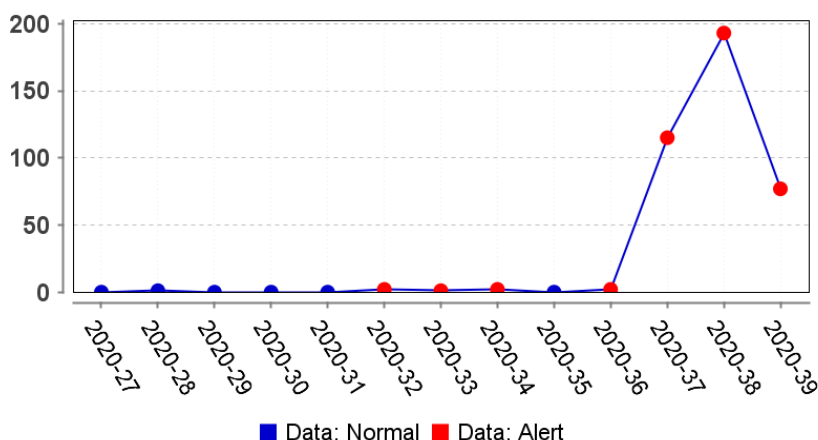


Figure 4. This syndrome definition looks for mentions of wildfire. The blue line shows the ED visit counts. ESSENCE-generated alerts (red, p-value ≤ 0.01) are shown.

Figure 5. Oregon's Smoke-related Visits Syndrome Definition, Oregon, 2020.

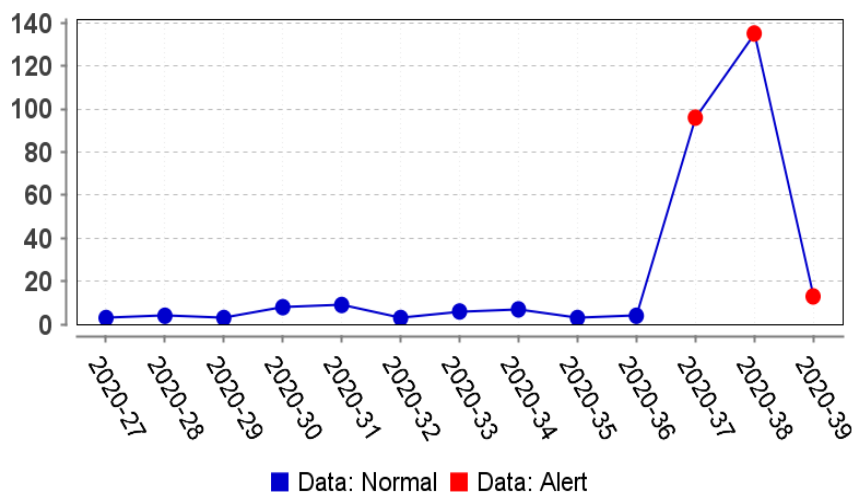


Figure 5. This syndrome definition looks for mentions of smoke. The blue line shows the ED visit counts. ESSENCE-generated alerts (red, p-value ≤ 0.01) are shown.

Trend Analysis

Reviewing past years of data is a critical exercise to understand a jurisdiction's baseline visit levels and seasonal patterns. In addition to testing syndrome definitions in local systems for basic functionality, one can assess which syndrome definitions detected anomalies soonest during past wildfire events, which definitions trend together, and which definitions correlate best with $PM_{2.5}$ observations. Depending on the scope and duration of past wildfire events, there may be variation in

seasonal and annual trends, i.e., during periods with very high air pollution, several syndrome definitions may alert and be correlated with PM_{2.5}, but when air pollution is lower but still elevated because of wildfire fewer syndrome definitions may do so. It is necessary to understand this information before a wildfire response so that limited staff resources can be used to monitor and communicate trends and prepare public health responses, rather than inputting syndrome definitions and researching past events for comparison purposes. One could also review the longer-term effects of wildfires that may present in syndromic data by pairing the novel wildfire and smoke definition with other definitions, such as ESSENCE mental health CC/DD categories. However, syndromic surveillance data may not be the best data source for extensive retrospective analysis of health outcomes associated with wildfires. Other data sources such as ED and hospital discharge data may be more standardized and available for more years. Note that the novel syndrome definitions presented here use ICD-10-CM codes, implemented in the U.S. healthcare system starting October 2015.

Understanding ED Visits Related to Wildfire and Smoke Events

To fully understand syndromic surveillance data, at least a limited manual review of visit details is critical to identify cases truly matching the intent of the syndrome definition, not just the definition. The balance between sensitivity and specificity is challenging [8]. Unless a syndrome definition is very narrow, unrelated visits will be captured. Assessing the change in magnitude of visit counts (i.e., statistically significant increases in visits above expected levels), percentage of visits, and categories of visits will provide insight into the number and types of visits associated with an event. Therefore, it is important to customize and refine syndrome definitions in response to changing conditions. Additionally, all syndrome definitions should be regularly reviewed.

Case Study: Disambiguating Visits During a Pandemic

The 2020 wildfire season was an unprecedented year with degraded air quality across Washington State for a sustained period. As a result, air quality dropped to very unhealthy or hazardous levels for Washington residents. Syndromic surveillance data was used to monitor increases in respiratory visits attributed to wildfires and the resulting poor air quality.

Respiratory visits were elevated across the state in EDs, hospital admissions, and urgent care clinics, corresponding with peak PM_{2.5} levels. These visits were most noticeable among the 18-44 (especially in urgent cares), 45-64, and 65+ year age groups. To distinguish between COVID-19 and air quality respiratory visits, the COVID-like illness (CLI) syndrome was excluded from the respiratory syndrome definition, essentially removing all visits with fever or a COVID diagnosis. After the exclusion, the same pattern in respiratory visits was observed, indicating COVID-19 cases were not being captured. In addition, the sustained elevation in visit counts also aligned with the smoke event.

An existing wildfire smoke syndrome definition was enhanced to identify visits to EDs, primary care, and urgent care facilities with a clinical diagnosis indicating smoke exposure/inhalation. In addition to free text terms, the discharge diagnosis included ICD-10-CM codes for smoke exposure, toxicity, and inhalation (i.e., J70.5, T59.81, X01.1, and X08.8). The syndrome definition was validated using a text analysis tool developed by staff with the NSSP and a manual review of syndromic surveillance records. This syndrome definition picked up relatively few visits outside of wildfire season. It was significantly elevated during the smoke event, indicating an effective syndrome definition for monitoring smoke exposure healthcare visits during a wildfire event. In addition, Washington visits were elevated during the two-week smoke event and similar across the state, age groups, and health care facility types.

Washington plans to continue its efforts to improve wildfire smoke surveillance tools for the upcoming 2021 season. In addition, their plans include developing a smoke-related cardiovascular syndrome definition in partnership with chronic disease specialists.

Conclusion

Syndromic surveillance is a powerful tool for public health response to environmental health emergencies. During wildfire events, public health response most often focuses on the effects of air pollution (PM_{2.5}) resulting from wildfire smoke. Health outcomes of interest include severe respiratory and cardiovascular disease and increased acute health events. Because of the need and request for guidance, the CSTE Wildfire and Smoke Syndromic Surveillance Workgroup developed and validated two novel syndrome definitions: 1) **Fire and Smoke Inhalation v1** and 2) **Air Quality-related Respiratory Illness v1**. The Fire and Smoke Inhalation v1 syndrome definition was correlated to PM_{2.5} observations. The broad **Air Quality-related Respiratory Illness v1** syndrome definition did not always correlate with PM_{2.5}, however, results improved when the definition was combined with more specific respiratory syndrome definitions or the wildfire and smoke syndrome definition. These novel syndrome definitions can be used in conjunction with other syndrome definitions and air pollution data to detect, understand, and monitor health events and support public health action. Additionally, comparing ED visit trends with other longitudinal datasets can provide a more comprehensive retrospective analysis into the impact of wildfires. Lastly, trend analysis can provide insights and inform the use and modification of syndrome definitions. Best practices include setting up a syndromic surveillance dashboard and communicating with partners and stakeholders before wildfire season.

References

1. Wooten. G. (n.d.). *Fire and fuels management: Definitions, ambiguous terminology, and references*. National Park Service. <https://www.nps.gov/olym/learn/management/upload/fire-wildfire-definitions-2.pdf>
2. American Association for the Advancement of Science. *Wildfire trends in the United States*. (2021). <https://www.sciline.org/wildfires/trends/#details>
3. U.S. Forest Service. *Wildland fire*. (2021). <https://www.fs.usda.gov/managing-land/fire>
4. Vose, J.M., D.L. Peterson, G.M. Domke, C.J. Fettig, L.A. Joyce, R.E. Keane, C.H. Luce, J.P. Prestemon, L.E. Band, J.S. Clark, N.E. Cooley, A. D’Amato, and J.E. Halofsky, 2018: Forests. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 232–267. doi: 10.7930/NCA4.2018.CH6
5. National Interagency Fire Center. (2021). *Fire information*. <https://www.nifc.gov/fire-information/statistics/wildfires>
6. California Air Resources Board, California Office of Environmental Health Hazard Assessment, U.S. Centers for Disease Control and Prevention, U.S. Forest Service, & U.S. Environmental Protection Agency. (2019). *Wildfire Smoke: A Guide for Public Health Officials*. EPA-452/R-19-901. <https://www.airnow.gov/publications/wildfire-smoke-guide/wildfire-smoke-a-guide-for-public-health-officials/>
7. Centers for Disease Control and Prevention (2021). *National Syndromic Surveillance Program*. <https://www.cdc.gov/nssp/documents/NSSP-overview.pdf>
8. Kumar, R.S., Adekoya, N., Close, N., Stein, Z., Baber, J., & ISDS Syndrome Definition Committee. (2019). *Developing, Evaluating, and Disseminating Definitions for Syndromic Surveillance in Public Health Practice: A Guidance Document*. International Society of Disease Surveillance. https://prod-knowledge-repository.s3-us-gov-west-1.amazonaws.com/references/SDC_Syndrome%20Definition%20Guidance%20document_FINAL.PDF
9. Berisha, V., Braun, C.R., Cameron, L., Hoppe, B.O., Lane, K., Mamou, F., Menager, H., Roach, M., White, J.R., Wurster, J., & CSTE Heat Syndrome Workgroup. (2016). *Heat-Related Illness Syndrome Query: A Guidance Document for Implementing Heat-Related Illness Syndromic Surveillance in Public Health Practice*. Council of State and Territorial Epidemiologists. https://cdn.ymaws.com/www.cste.org/resource/resmgr/pdfs/pdfs2/CSTE_Heat_Syndrome_Case_Defi.pdf
10. Adekoya, N., Braun, C.R., Harris-Franklin, L., Frick, A., Jagger, M., Kretschmer, M., Lane, K., Mamou, F., McCall, H., Menager, H., Roach, M., & CSTE Heat and Cold Syndrome Workgroup. (2019). *Cold-Related Illness Query: Guidance for Implementing Cold-Related Illness Syndromic Surveillance in Public Health Practice*. Council of State and Territorial Epidemiologists. https://cdn.ymaws.com/www.cste.org/resource/resmgr/climate/CRI_Syndrome_Definition_Guid.pdf
11. Harduar Morano, L., Jagger, M.A., Barrett, E.C., Berisha, V., Borjan, M., Heitzinger, K., Kumar, R., Lane, K., Lumia, M., Menager, H., Thie, L., & CSTE Climate and Health Syndromic Surveillance Workgroup. (2017). *Syndromic Surveillance Climate and Health Guidance Document: How Jurisdictions Can Use Surveillance to Quantify and Track Climate-Related Health Impact*. Council of State and Territorial Epidemiologists. https://cdn.ymaws.com/www.cste.org/resource/resmgr/pdfs/pdfs2/Syndromic_surveillance_clima.pdf

12. Radhakrishnan, L., Personal communication, (January 19, 2021).
13. Reid, C. E., Brauer, M., Johnston, F. H., Jerrett, M., Balmes, J. R., & Elliott, C. T. (2016). Critical Review of Health Impacts of Wildfire Smoke Exposure. *Environmental Health Perspectives*, 124, 9, 1334-43. <https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.1409277>
14. Reid, C. E., & Maestas, M. M. (2019). Wildfire smoke exposure under climate change: impact on respiratory health of affected communities. *Current Opinion in Pulmonary Medicine*, 25, 2, 179-187. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6743728/>
15. U.S. Environmental Protection Agency. *Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI)*. (2018). EPA 454/B-18-007. <https://www.airnow.gov/sites/default/files/2020-05/aqi-technical-assistance-document-sept2018.pdf>
16. Radhakrishnan, L., Personal communication, (January 13, 2021).
17. Oregon ESSENCE. (2017). Using Weather and Environmental Data in ESSENCE. https://www.oregon.gov/oha/PH/DISEASES/CONDITIONS/COMMUNICABLE/DISEASE/PREPAREDNESS/SURVEILLANCE/EPIDEMIOLOGY/ESSENCE/Documents/Weather_Environmental_Data_in_ESSENCE.pdf
18. National Syndromic Surveillance Program (2021). *About Our Community*. <https://nsspcommunityofpractice.org/about-the-nssp-community-of-practice/>
19. National Syndromic Surveillance Program (2021). *Join and Participate in the NSSP CoP*. <https://nsspcommunityofpractice.org/join-participate-and-get-involved/#subcommittee>
20. Centers for Disease Control and Prevention. (2017). *BioSense Platform Quick Start Guide to Using ESSENCE*. <https://www.cdc.gov/nssp/biosense/docs/BioSense-Platform-Quick-Start-Guide-for-ESSENCE.pdf>
21. National Syndromic Surveillance Program (2020). *Disaster-related Mental Health v1 - Syndrome Definition Subcommittee*. <https://knowledgerepository.syndromicsurveillance.org/disaster-related-mental-health-v1-syndrome-definition-subcommittee>

Appendix A: Validation Template

CSTE Wildfire SyS Workgroup Query Validation Template

Process Outline

Step 1: Time Series Visualization [1]

- Document: Wildfire Season/Year
 - Brief description
 - Time period (can be a whole calendar year, a fire season, or other time period)
 - Geography (jurisdiction-wide and region(s) impacted)
- Query: **wildfire/smoke** (in CC/DD field, if other, specify)
 - Time series visualization (review data details, **save data table**)
 - Summary statistics (reporting facilities, top words)
 - *Optional*: Stratify by age group (explore interactive view)
 - *Optional*: Stratify by syndrome (explore interactive view)
 - Document observations (from data details, summary statistics, review of stratification results, etc.)
- Query: **respiratory** (in CC/DD field, if other, specify)
 - Time series visualization (review data details, **save data table**)
 - Summary statistics (reporting facilities, top words)
 - *Optional*: Stratify by age group (explore interactive view)
 - *Optional*: Stratify by syndrome (explore interactive view)
 - Document observations (from data details, summary statistics, review of stratification results, etc.)

Step 2: Compare to AQ [2]

- Document: Wildfire Season/Year/Event
 - Brief description
 - Time period (can be a whole calendar year, a fire season, a specific event, or other time period)
 - Geography (limit to region(s) impacted and nearest AQ monitor)
- Query: **wildfire/smoke**
 - Time series visualization with PM2.5 overlay (**save data tables for query and AQ**)
 - Document observations, include correlation
- Query: **respiratory**
 - Time series visualization with PM2.5 overlay (**save data tables for query and AQ**)
 - Document observations, include correlation

Step 3: Compare Queries to Each Other

- Document: Wildfire Season/Year (probably the same as Step 1)
- Query: **wildfire/smoke AND respiratory together**
 - Time series visualization (**save data tables for queries**)
 - Document observations, include correlation

Step 4: Document Final Thoughts

- **Wildfire/smoke**
 - Recommended changes to the proposed query

- Overall opinion of the utility
- Questions or concerns for workgroup
- **Respiratory**
 - Recommended changes to the proposed query
 - Overall opinion of the utility
 - Questions or concerns for workgroup

Step 5: Submit Findings

- Document validation using this template and guide.
- Note: If you inserted images into this word document, you may need to PDF the file to make it small enough to email back.
- If allowed, save data tables with observed and expected counts for two proposed queries and AQ data for time period and geographies tested - please label intuitively.
- Submit validation template and data tables.

Validation References

1. [Developing, Evaluating, and Dissemination Definitions for Syndromic Surveillance in Public Health Practice: A Guidance Document, January 2019](#)
2. [Heat-related Illness Syndrome Query: A Guidance Document for Implementing Heat-Related Illness Syndromic Surveillance in Public Health Practice](#)

Appendix B: Validation Guide

CSTE Wildfire Sys Workgroup Query Validation Guide

Proposed Queries

Fire and Smoke Inhalation Definition - ESSENCE Syntax CC/DD

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(,^[;/ ]J70.5^,or,^[;/ ]J705^,or,^[;/ ]X08.8^,or,^[;/ ]X088^,or,^[;/ ]X01.1^,or,^[;/ ]X011^,or,^[;/ ]T59.81^,or,^[;/ ]T5981^,or,^[;/ ]423123007^,or,^wild fire^,or,^wildfire^,or,(^ ash ^,andnot,(^dr ash^,or,^pcp ash^,or,^ash wed^,or,^ash cath^,)),or,(^smoke ^,andnot,(^ a smoke^,or,^ to smoke^,or,^alarm^,or,^can smoke^,or,^denies smoke^,or,^detector^,or,^did smoke^,or,^does not smoke^,or,^does smoke^,or,^go and smoke^,or,^go smoke^,or,^he smoke^,or,^husband smoke^,or,^n_t smoke^,or,^never smoke^,or,^no smoke^,or,^or smoke^,or,^out and smoke^,or,^outside and smoke^,or,^smoke bomb^,or,^smoke shop^,or,^smoke week^,or,^smoke[drs]^,or,^smoke^a lot^,or,^they smoke^,or,^upstairs and smoke^,or,^was smoking^,or,^wife smoke^,or,^without smoke^,or,^blunt^,or,^joint^,)),),andnot,(^canab^,or,^cannab^,or,^ci g^,or,^crack^,or,^her[io][oi]n^,or,^ k2 ^,or,^marij^,or,!meth!,or,!pot!,or,^spice^,or,^tobac^,or,^weed^,or,^no rmal saline^,or,^ on fire^,or,^cooking^,or,^kitchen^,or,^motor [bc]^,or,^motor[bc]^,or,(^motor vehicle^,and,(^collision^,or,^accident^,or,^crash^,)),),)
```

Air Quality-Related Respiratory Illness Definition - ESSENCE Syntax CC/DD

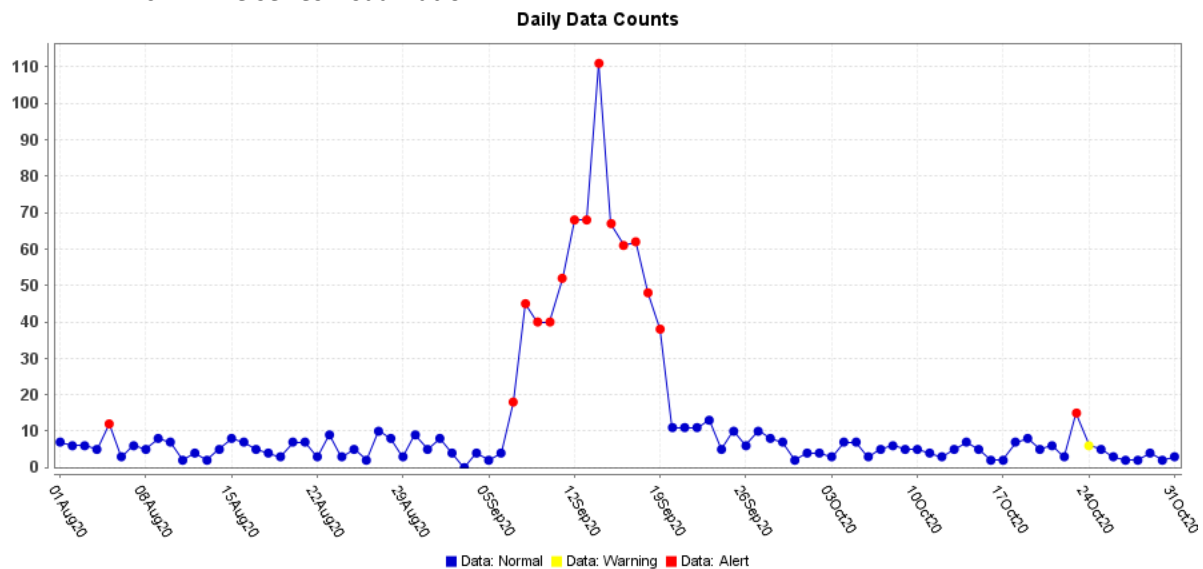
```
(,^[;/ ]J20^,or,^acute bronchitis^,or,^[;/ ]J43^,or,^emphysema^,or,^[;/ ]J44^,or,^ COPD^,or,^chronic obstructive airway disease^,or,^chronic obstructive lung disease^,or,^chronic obstructive pulmonary disease^,or,^[;/ ]J45^,or,^asthma^,or,^bronchasthma^,or,^ RAD ^,or,^reactive airway disease^,or,^[;/ ]J80^,or,^difficulty breath^,or,^breathing problem^,or,^chest tightness^,or,^chronic cough^,or,^[;/ ]R06.0 ^,or,^[;/ ]R060 ^,or,^[;/ ]R06.02^,or,^[;/ ]R0602^,or,^dyspnea^,or,^shortness of breath^,or,^ SOB ^,or,(^wheez^,andnot,(^cough^,or,^cold^,or,^congestion^,)),andnot,( ^,^[;/ ]R50.9^,or,^[;/ ]R509^,or,^febrile^,or,^fever^,or,^high temp^,),)
```

Example – Fire and Smoke Inhalation Only

Note: Sections where participating validators will expand on example are highlighted in yellow.

Step 1: Time Series Visualization

- **Document:** Wildfire Season/Year
 - Brief description: Here you will write 1-3 sentences about the time period you are using for this validation exercise. You can choose a whole year (calendar or otherwise), a fire season, or other period.
 - Time period: Aug 1 - Oct 31, 2020
 - Geography (jurisdiction-wide and region(s) impacted): DHHS region 10, limited details
- Query: **wildfire/smoke**
 - Time series visualization



Additional actions:

- Review data details
- Save data table, label intuitively

- Summary statistics

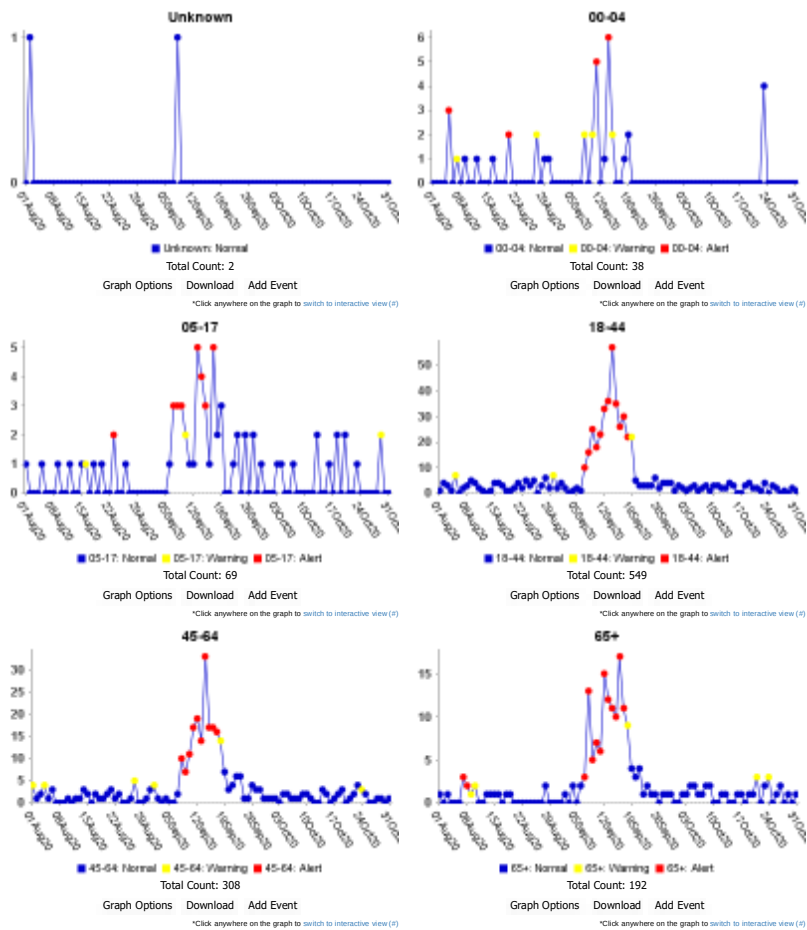
- Check number of facilities reporting for anomalies
- Review top 50 words

Top 50 Words in ChiefComplaintParsed

Analyzed 1158 rows.

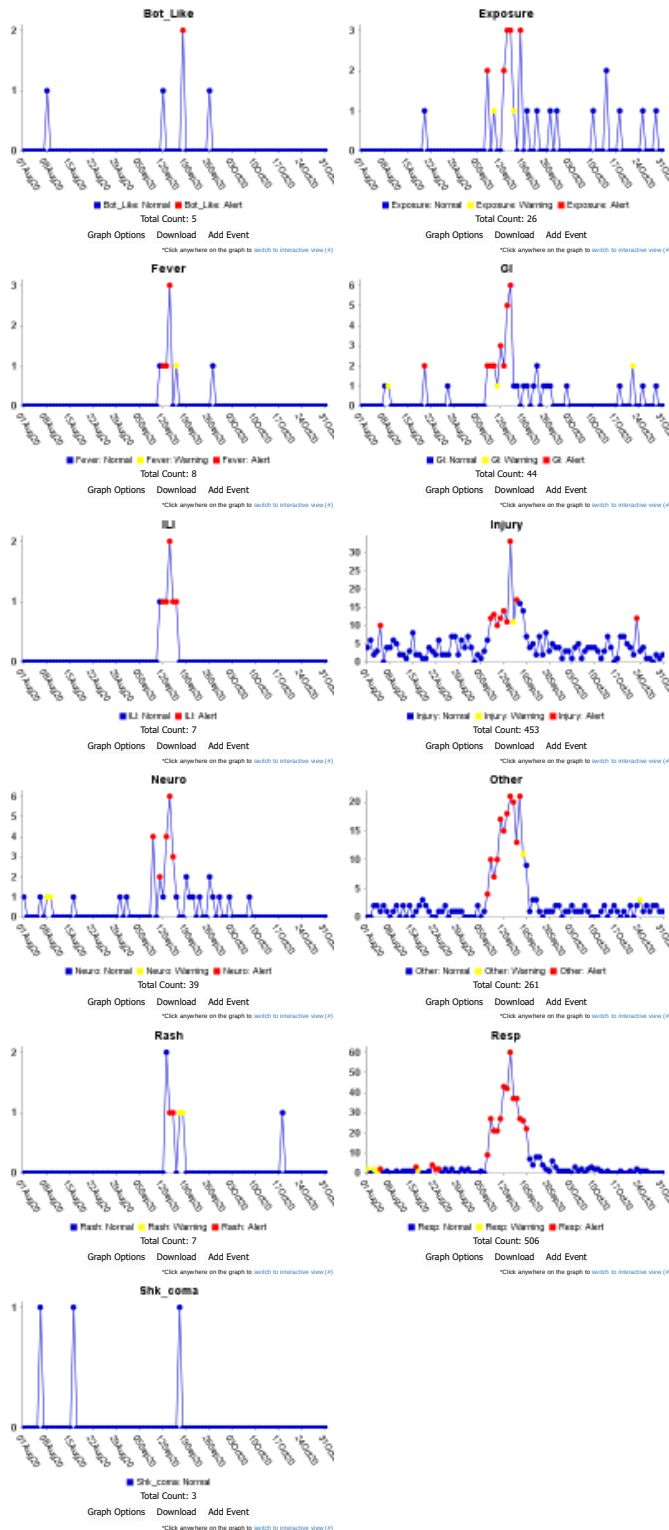
Rank	Word	Count	Rank	Word	Count
1	BREATH	315	26	RIGHT	24
2	SHORTNESS	311	27	STATES	23
3	SMOKE	309	28	EXPOSURE	22
4	INHALATION	169	29	DUE	21
5	PAIN	130	30	ARM	21
6	COUGH	117	31	FOLLOW	20
7	BURN	108	32	PROBLEM	20
8	CHEST	91	33	HAND	19
9	BREATHING	70	34	DISEASE	18
10	ASTHMA	63	35	NAUSEA	18
11	HEADACHE	57	36	PCP	18
12	PATIENT	54	37	EMS	17
13	RESPIRATORY	49	38	DIZZINESS	16
14	THROAT	48	39	TROUBLE	14
15	SORE	39	40	HISTORY	14
16	LEFT	36	41	AMB	14
17	INFECTION	34	42	UNSPECIFIED	13
18	TENT	32	43	ENCOUNTER	13
19	UPPER	32	44	PULMONARY	13
20	BURNS	31	45	SINUS	12
21	INJURY	29	46	CHRONIC	12
22	DIFFICULTY	27	47	MEDICATION	12
23	FIRE	27	48	PRESSURE	12
24	CONGESTION	25	49	OBSTRUCTIVE	11
25	ADULT	25	50	REPORTS	11

- Stratify by age group



Additional action: Explore anomalies in interactive view

- Stratify by syndrome

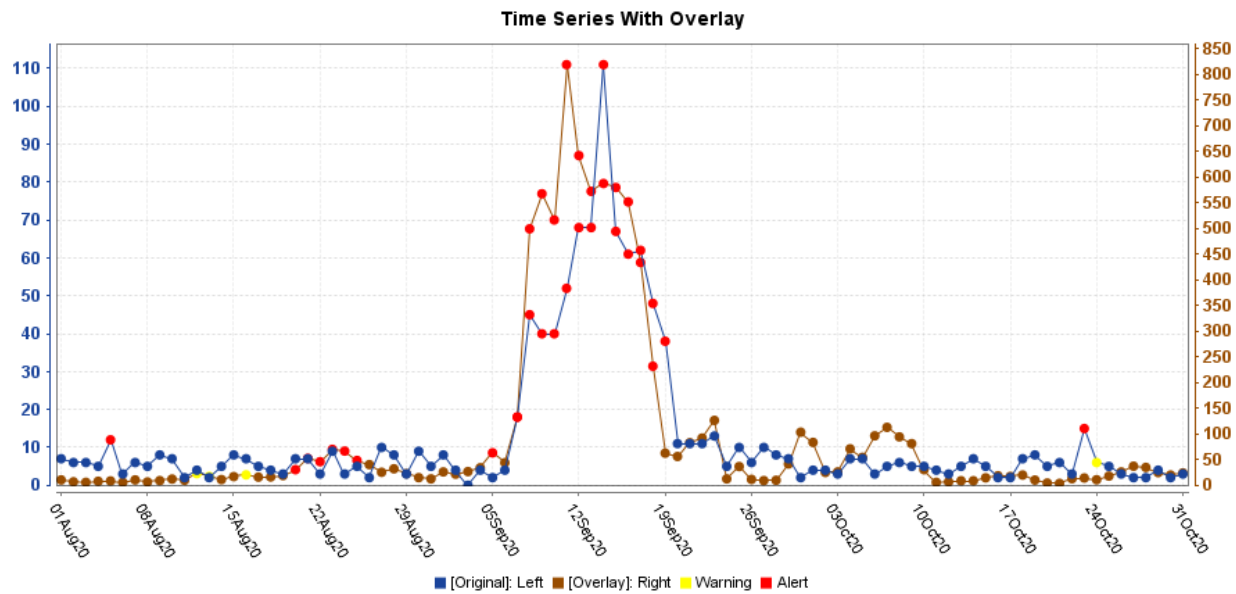


Additional action: Explore anomalies in interactive view

- **Document observations:** Here you will briefly describe findings from data details, summary statistics, review of stratification results, etc.

Step 2: Compare to AQ

- **Document:** Wildfire Season/Year/Event
 - Brief description: Here you will write 1-3 sentences about the fire season, year, or event you are using for this validation exercise.
 - Time period: Aug 1 - Oct 31, 2020
 - Geography limit to region(s) impacted and nearest AQ monitor): DHHS region 10, limited details; Air quality PM2.5 24 hour, time and station MAX from Oregon
- **Query: Fire and Smoke Inhalation v1**
 - Time series visualization with PM2.5 overlay

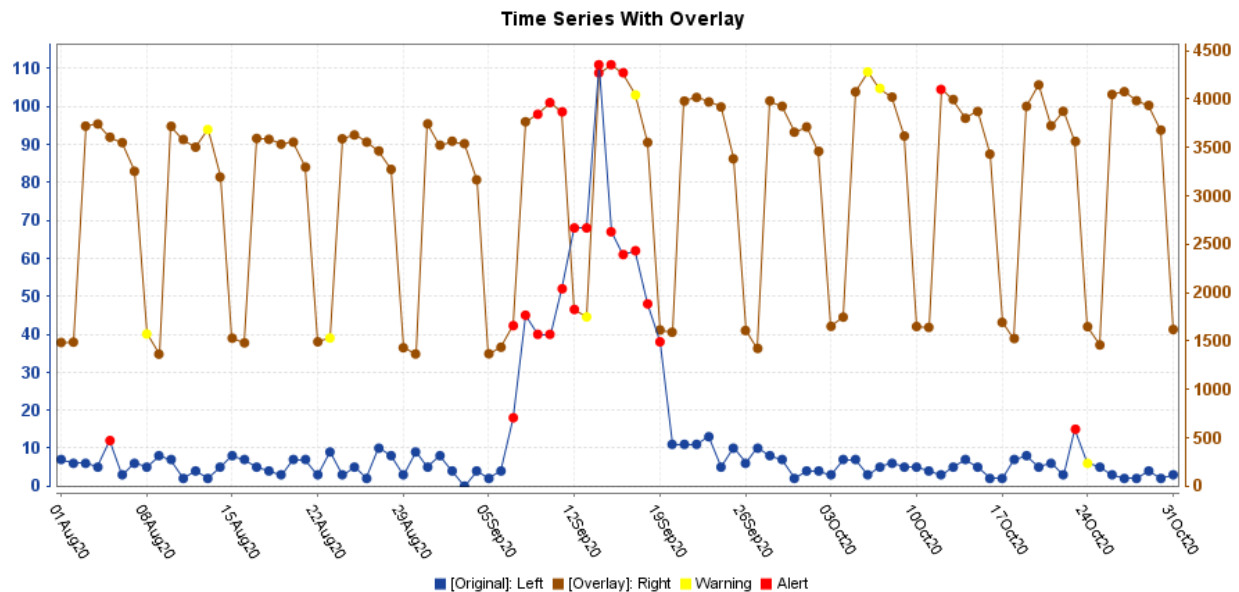


Additional actions:

- Save AQ data table, label intuitively
- Document observations, include correlation

Step 3: Compare Queries to Each Other

- **Document:** Wildfire Season/Year (probably same as Step 1)
 - Brief description: Here you will write 1-3 sentences about the fire season you are using for this validation exercise.
 - Time period: Aug 1 - Oct 31, 2020
 - Geography (jurisdiction-wide and region(s) impacted): DHHS region 10, limited details
- **Query: Fire and Smoke Inhalation v1 AND Air Quality together**
 - Time series visualization



Additional action: Document observations, include correlation

Step 4: Document Final Thoughts

- **Fire and Smoke Inhalation v1**
 - Recommended changes to proposed query
 - Overall opinion of utility
 - Questions or concerns for workgroup
- **Air Quality-Related Respiratory Illness v1**
 - Recommended changes to proposed query
 - Overall opinion of utility
 - Questions or concerns for workgroup

Step 5: Submit Findings

- Document validation using this guide as a template
- Save data tables with observed and expected counts for two proposed queries and AQ data for time period and geographies tested - please label intuitively
- Submit validation template and data tables to Meredith (mph.jagger@use.startmail.com) by **Friday March 5, 2021**

“How To” Tips

Step 1: Time Series Visualization

- Query
 - Go to [Query Portal]
 - Select your datasource, resolution, and dates
 - Under Available Query Fields (Left sidebar) -> CC and DD
 - Enter in proposed query text
 - [Select]
 - Check Selected Query Fields (Right sidebar)
 - [Time Series]

The screenshot shows the 'Query Wizard' interface with the following settings:

- Datasource:** Patient Location (Limited Details)
- Time Resolution:** Daily
- Detector:** Regression/EWMA 1.2
- As Percent Query:** No Percentage Query
- Start Date:** 01Aug20
- End Date:** 31Oct20

Available Query Fields (Left sidebar):

- DDI Percent Std Dev Last Year
- DDI Percent Last 2 Years
- DDI Percent Std Dev Last 2 Years
- CC and DD Category
- CC and DD
- CC and DD Category Free Text
- Syndrome Subsyndrome CCDD Com.
- Syndrome Free Text
- SubSyndrome Free Text

Selected Query Fields (Right sidebar):

- Geography System**
 - DHHS Region
- HHS Region**
 - Region 10
- Medical Grouping System**
 - ESSENCE Syndromes
- CC and DD**
 - (,^,;:/ }170.5^,or,^;:/ }1705^,or,^;:/ }X08.8^,or,^;:/ }X088^,or,^;:/ }X01.1^,or,^;:/ }X011^,or,^;:/ }

Query Text:

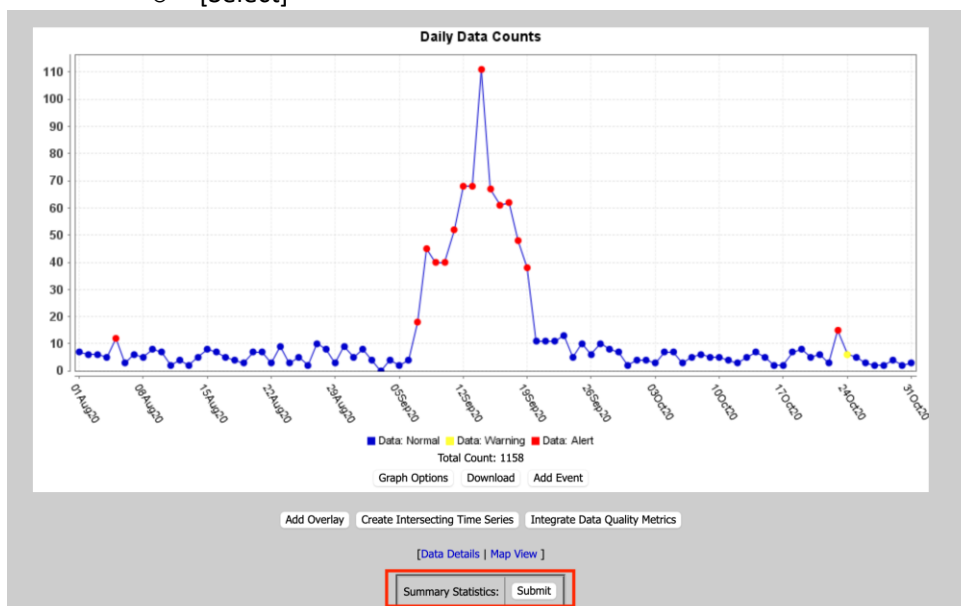
```
lot^,or,^they smoke^,or,^upstairs and smoke^,or,^was smoking^,or,^wife smoke^,or,^without smoke^,or,^blunt^,or,^joint^,or,^),andnot,(^canab^,or,^cannab^,or,^cig^,or,^crack^,or,^her[ig][oi]n^,or,^k2 ^,or,^marij^,or,^methl,or,^potl,or,^spice^,or,^tobac^,or,^weed^,or,^normal saline^,or,^ on fire^,or,^cooking^,or,^kitchen^,or,^motor [bc]^,or,^motor[bc]^,or,^motor vehicle^,and, (^collision^,or,^accident^,or,^crash^,or,^),)
```

Also apply the search string to:

- Discharge Diagnosis
- CC and DD Category Free Text
- Syndrome Free Text
- SubSyndrome Free Text

Buttons: Table Builder, Time Series, Data Details, Text Analysis, Graph Builder, Overview, Adv Qry, Explain Qry, Reset

- View Summary Statistics
 - Under Time Series visualization, Summary Statistics
 - [Select]



- View Data Details

- Under Time Series visualization
- [Data Details]

Graph Options Download Add Event

Add Overlay Create Intersecting Time Series Integrate Data Quality Metrics

[Data Details] Map View

Summary Statistics: Submit

Show Weekly Time Series Viewer: Submit

Select options for creating stacked graph: Facility HHS Region Syndrome MedicalSubGrouping Submit

Select detectors to compare: Regression/EWMA 1.2 No Detection Regression 1.2 EWMA 1.2 CDC-C1 Submit

Download to Excel

Data Data Table

Data Link	Map Link	Date	Data	Expected	Detection
Data Details	Map View	31Oct2020	3	4.964	0.782
Data Details	Map View	30Oct2020	2	4.964	0.854
Data Details	Map View	29Oct2020	4	5.143	0.698
Data Details	Map View	28Oct2020	2	5.321	0.896
Data Details	Map View	27Oct2020	2	5.5	0.853

- Save Data Table
 - Under Time Series visualization
 - [Download to Excel]

Graph Options Download Add Event

Add Overlay Create Intersecting Time Series Integrate Data Quality Metrics

[Data Details] Map View

Summary Statistics: Submit

Show Weekly Time Series Viewer: Submit

Select options for creating stacked graph: Facility HHS Region Syndrome MedicalSubGrouping Submit

Select detectors to compare: Regression/EWMA 1.2 No Detection Regression 1.2 EWMA 1.2 CDC-C1 Submit

Download to Excel

Data Data Table

Data Link	Map Link	Date	Data	Expected	Detection
Data Details	Map View	31Oct2020	3	4.964	0.782
Data Details	Map View	30Oct2020	2	4.964	0.854
Data Details	Map View	29Oct2020	4	5.143	0.698
Data Details	Map View	28Oct2020	2	5.321	0.896
Data Details	Map View	27Oct2020	2	5.5	0.853

- Stratify by age group
 - From Time Series visualization

- [+] Data Series Options
- Across Graph Stratification = Age Group
- [Update]

The screenshot shows the 'Data Series Options' configuration panel. The 'Across Graphs Stratification' dropdown is set to 'Age Group'. The 'Graph Options' section shows 'Multiple Graphs (Small)' selected. The 'Remove Zero Series' checkbox is checked. An 'Update' button is at the bottom right. The left sidebar shows 'Configuration Options' and 'Data Series Options' expanded.

- Stratify by syndrome
 - From Time Series visualization
 - [+] Data Series Options
 - Across Graph Stratification = Syndrome
 - [Update]

The screenshot shows the 'Data Series Options' configuration panel. The 'Across Graphs Stratification' dropdown is set to 'Syndrome'. The 'Graph Options' section shows 'Multiple Graphs (Small)' selected. The 'Remove Zero Series' checkbox is checked. An 'Update' button is at the bottom right. The left sidebar shows 'Configuration Options' and 'Data Series Options' expanded.

Step 2: Compare to AQ

- Time series visualization with PM2.5 overlay
 - From Time Series visualization of **Air Quality-Related Respiratory Illness v1 query**
 - [Add Overlay]
 - Query Portal for Overlay is displayed
 - Select Datasource = Air Quality
 - -> Air Quality Station (pick closest to fire event)
 - Use PM 2.5-24hr Max
 - Select the SAME resolution and dates as query 1
 - [Add Overlay]
 - Use default configurations
 - [Display Overlay]

Note: For the example, statewide Oregon data used here since health data were from DHHS region 10.

Step 3: Compare Queries to Each Other

- Time series visualization with second query overlay
 - From Time Series visualization of **Fire and Smoke Inhalation v1**
 - [Add Overlay]
 - Query Portal for Overlay is displayed
 - Select the SAME datasource, resolution, and dates as query 1
 - Under Available Query Fields (Left sidebar) -> CC and DD
 - Enter in proposed query text for **Air Quality-Related Respiratory Illness Definition**
 - [Select]
 - Check Selected Query Fields (Right sidebar)
 - [Add Overlay]

- Use default configurations
- [Display Overlay]

Add Overlay

Datasource: Patient Location (Limited Details) Time Resolution: Daily Detector: Regression/EWMA 1.2 As Percent Query: No Percentage Query Start Date: 01Aug20 End Date: 31Oct20

Available Query Fields

- Discharge Diagnosis
 - Discharge Diagnosis Available
 - Discharge Diagnosis Informative
 - Chief Complaint Available
 - Chief Complaint Informative
 - DDI Percent All Time
 - DDI Percent Std Dev All Time
 - DDI Percent Std Dev Last 6 Months
 - DDI Percent Std Dev Last 6 Month
 - DDI Percent Last Year
 - DDI Percent Std Dev Last Year
 - DDI Percent Last 2 Years
 - DDI Percent Std Dev Last 2 Years
- CC and DD
 - CC and DD Category
 - CC and DD
 - CC and DD Category Free Text
 - Syndrome Subsyndrome CCDD Comb
 - Syndrome Free Text
 - Subsyndrome Free Text

CC and DD

Select Help Query Builder

(,^[/]J20^,or^acute bronchitis^,or^[/]J43^,or^emphysema^,or^[/]J44^,or^ COPD^,or^chronic obstructive airway disease^,or^chronic obstructive lung disease^,or^chronic obstructive pulmonary disease^,or^[/]J45^,or^asthma^,or^bronchasthma^,or^ RAD ^,or^reactive airway disease^,or^[/]J80^,or^difficulty breath^,or^breathing problem^,or^chest tightness^,or^chronic cough^,or^[/]R06.0 ^,or^[/]R060 ^,or^[/]R06.02^,or^[/]R0602^,or^dyspnea^,or^shortness of breath^,or^ SOB ^,or^(,^wheeze^,or^rhinorrhea^,or^cough^,or^cold^,or^congestion^,^),and^,^,^[/]J50.9^,or^[/]J509^,or^febrile^,or^fever^,or^high temp^,^))

Also apply the search string to:

- Discharge Diagnosis
- CC and DD Category Free Text
- Syndrome Free Text
- Subsyndrome Free Text
- Chief Complaint Orig Free Text
- Chief Complaint Combo Free Text
- Admit Reason Code
- Admit Reason Combo
- Discharge Diagnosis Combo Free Text

Add Overlay Cancel

Selected Query Fields

- Geography System**
 - DHHS Region
- HHS Region**
 - Region 10
- Medical Grouping System**
 - ESSENCE Syndromes
- CC and DD**
 - (,^[/]J20^,or^acute bronchitis^,or^[/]J43^,or^emphysema^,or^[/]J44^,or^ COPD^,or^chronic obstructive airway disease^,or^chronic obstructive lung disease^,or^chronic obstructive pulmonary disease^,or^[/]J45^,or^asthma^,or^bronchasthma^,or^ RAD ^,or^reactive airway disease^,or^[/]J80^,or^difficulty breath^,or^breathing problem^,or^chest tightness^,or^chronic cough^,or^[/]R06.0 ^,or^[/]R060 ^,or^[/]R06.02^,or^[/]R0602^,or^dyspnea^,or^shortness of breath^,or^ SOB ^,or^(,^wheeze^,or^rhinorrhea^,or^cough^,or^cold^,or^congestion^,^),and^,^,^[/]J50.9^,or^[/]J509^,or^febrile^,or^fever^,or^high temp^,^))

MyFilter: Create

Configure Overlay

Basic Parameters

Style: Single Date Alignment: Actual Dates Days from Today: Start Date: End Date:

Denominator Parameters

Use Denominator: Denominator: Show Axis Left Axis Right Line Graph Bar Graph Series Title

Show	Axis Left	Axis Right	Line Graph	Bar Graph	Series Title
☒ Original	☒	☐	☒	☐	Original
☒ Overlay	☐	☒	☒	☐	Overlay
☐ Percent	☐	☐	☐	☐	Percent

Graph Title: Time Series With Overlay Left Axis Label: Right Axis Label:

Legend

Style

Single: Plots all queries on the same graph.

Multiple Large: Plots each query on its own large graph.

Multiple Small: Plots each query on its own small graph.

Date Alignment

Actual Dates: Uses the dates saved with each individual query.

Global Dates: Uses the dates provided on the form for all selected queries.

Start Together: Uses the dates saved with each individual query, but aligns them so that they all start at the leftmost side of the graph.

End Together: Uses the dates saved with each individual query, but aligns them so that they all start at the rightmost side of the graph.

Display Overlay Cancel

Appendix C: CDC-Modified Queries

ESSENCE Syntax: Fire and Smoke Inhalation v1

Description: To identify emergency department and ambulatory care visits associated with fire and smoke inhalation. Primary purpose of query is to identify wildfire related visits, although the query may return visits not limited to wildfires. Developed by the Council of State and Territorial Epidemiologists, National Center for Environmental Health and the NSSP Community of Practice.

Original Definition

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(,^[;/ ]J70.5^,or,^[;/ ]J705^,or,^[;/ ]X08.8^,or,^[;/ ]X088^,or,^[;/ ]X01.1^,or,^[;/ ]X011^,or,^[;/ ]T59.81^,or,^[;/ ]T5981^,or,^[;/ ]423123007[;/ ]^,or,^wild fire^,or,^wildfire^,or,(^smoke ^,andnot,(^ a smoke^,or,^ to smoke^,or,^alarm^,or,^can smoke^,or,^denies smoke^,or,^detector^,or,^did smoke^,or,^does not smoke^,or,^does smoke^,or,^go and smoke^,or,^go smoke^,or,^he smoke^,or,^husband smoke^,or,^n_t smoke^,or,^never smoke^,or,^no smoke^,or,^or smoke^,or,^out and smoke^,or,^outside and smoke^,or,^secondhand^,or,^second hand^,or,^smoke bomb^,or,^smoke shop^,or,^smoke week^,or,^smoke[drs]^,or,^smoke^a lot^,or,^they smoke^,or,^upstairs and smoke^,or,^was smoking^,or,^wife smoke^,or,^without smoke^,or,^blunt^,or,^joint^,)),),andnot,(^canab^,or,^vape^,or,^cannab^,or,^cig^,or,^crack^,or,^her[io][oi]n^,or,^ k2 ^,or,^marij^,or,^meth!,or,^pot!,or,^spice^,or,^tobac^,or,^weed^,or,^normal saline^,or,^ on fire^,or,^cooking^,or,^kitchen^,or,^ stove ^,or,^ oven ^,or,^motor [bc]^,or,^motor[bc]^,or,(^motor vehicle^,and,(^collision^,or,^accident^,or,^crash^,)),)
```

Changes:

- Added the term “^smoke” to capture CCs that end with smoke
- Added a negation for term “vape”
- Changed syntax for “k2”, “stove”, “oven” !term! format
- Added ICD-9 code equivalents:
 - o 508.2 ICD-9 for respiratory conditions due to smoke inhalation (removed the ‘space’ in non-decimal version)
 - o E898.1 ICD-9 for exposure to other specified smoke, fire, and flames
 - o E892 ICD-9 for exposure to smoke in uncontrolled fire, not in building or structure
- Adding SNOMED equivalents:
 - o 426936004 – Smoke Inhalation Injury
 - o 217486005 – uncontrolled fire in forest
 - o 217485009 – Conflagration not in building or structure
 - o 242462007 – Accident caused by fire in standing farm crops (event)
 - o 217487001 – Uncontrolled fire in grass (event)
 - o 217488006 – Uncontrolled fire in hay (event)
 - o 217491006 – Uncontrolled fire on prairie (event)
 - o 217489003 – Uncontrolled lumber fire (event)
 - o 426936004 – Smoke inhalation injury (disorder)

Revised Definition:

```
(,^[;/ ]J70.5^,or,^[;/ ]J705^,or,^[;/ ]X08.8^,or,^[;/ ]X088^,or,^[;/ ]X01.1^,or,^[;/ ]X011^,or,^[;/ ]T59.81^,or,^[;/ ]T5981^,or,^[;/ ]423123007[;/ ]^,or,^[;/ ]508.2^,or,^[;/ ]5082[;/ ]^,or,^[;/ ]E898.1^,or,^[;/ ]E8981^,or,^[;/ ]E892^,or,^[;/ ]426936004[;/ ]^,or,^[;/ ]217486005[;/ ]^,or,^[;/ ]217485009[;/ ]^,or,^[;/ ]242462007[;/ ]^,or,^[;/ ]217487001[;/ ]^,or,^[;/ ]217488006[;/ ]^,or,^[;/ ]217491006[;/ ]^,or,^[;/ ]217489003[;/ ]^,or,^[;/ ]426936004[;/ ]^,or,^wild fire^,or,^wildfire^,or,(^smoke ^,or,^smoke,),andnot,(^ a smoke^,or,^ to smoke^,or,^alarm^,or,^can smoke^,or,^denies smoke^,or,^detector^,or,^did smoke^,or,^does not smoke^,or,^does smoke^,or,^go and smoke^,or,^go smoke^,or,^he smoke^,or,^husband smoke^,or,^n_t smoke^,or,^never smoke^,or,^no smoke^,or,^or smoke^,or,^out and smoke^,or,^outside and smoke^,or,^secondhand^,or,^second hand^,or,^smoke bomb^,or,^smoke
```

```
shop^,or,^smoke week^,or,^smoke[drs]^,or,^smoke^a lot^,or,^they smoke^,or,^upstairs and
smoke^,or,^was smoking^,or,^wife smoke^,or,^without
smoke^,or,^blunt^,or,^joint^,),),andnot,(,^canab^,or,^vape^,or,^cannab^,or,^cig^,or,^crack^,or,
^her[io][oi]n^,or,!k2!,or,^marij^,or,!meth!,or,!pot!,or,^spice^,or,^tobac^,or,^weed^,or,^normal
saline^,or,^ on fire^,or,^cooking^,or,^kitchen^,or,!stove!,or,!oven!,or,^motor
[bc]^,or,^motor[bc]^,or,(,^motor vehicle^,and,(,^collision^,or,^accident^,or,^crash^,),),)
```

ESSENCE Syntax: CDC Air Quality-related Respiratory Illness v1

Description: To identify emergency department and ambulatory care visits for respiratory illnesses associated with poor air quality. Definition includes chief complaint terms and diagnosis codes for acute bronchitis, emphysema, chronic obstructive airway disease, chronic obstructive lung disease, chronic obstructive pulmonary disease, asthma, bronchasthma, reactive airway disease, acute respiratory distress syndrome, difficulty breathing, chest tightness, dyspnea, shortness of breath and wheezing. Developed by the Council of State and Territorial Epidemiologists, National Center for Environmental Health and the NSSP Community of Practice.

Original Definition:

```
(,^[;/ ]J20^,or,^acute bronchitis^,or,^[;/ ]J43^,or,^emphysema^,or,^[;/ ]J44^,or,^
COPD^,or,^chronic obstructive airway disease^,or,^chronic obstructive lung disease^,or,^chronic
obstructive pulmonary disease^,or,^[;/ ]J45^,or,^asthma^,or,^bronchasthma^,or,^ RAD
^,or,^reactive airway disease^,or,^[;/ ]J80^,or,^difficulty breath^,or,^breathing
problem^,or,^chest tightness^,or,^chronic cough^,or,^[;/ ]R06.0 ^,or,^[;/ ]R060 ^,or,^[;/
]R06.02^,or,^[;/ ]R0602^,or,^dyspnea^,or,^shortness of
breath^,or,!SOB!,or,(,^wheez^,andnot,(,^cough^,or,^cold^,or,^congestion^,)),andnot,(,^[;/
]R50.9^,or,^[;/ ]R509^,or,^febrile^,or,^fever^,or,^high temp^,),)
```

Changes:

- Changed syntax for “COPD” to !term! format
- Adding ICD-9 equivalents:
 - o 466.0 – Acute Bronchitis
 - o 492 – Emphysema (includes 2 sub-codes for emphysematous bleb and other emphysema; included this without ‘space’)
 - o 496 – Chronic airway obstruction, not elsewhere classified – translates to COPD ICD-10 CM code (included this without ‘space’)
 - o 493 – Asthma (included this without ‘space’)
 - o 518.82 – Other pulmonary insufficiency, not elsewhere classified (Acute respiratory distress)
 - o 786.05 – Shortness of breath
 - o 786.09 – Dyspnea
 - o 786.07 – Wheezing
- Adding SNOMED equivalents:
 - o 10509002 – Acute bronchitis
 - o 49158009, 17569003, 789677001 – Emphysema
 - o 13645005, 13645005 – Chronic airway obstruction
 - o 195967001 – Asthma
 - o 373895009 – Acute respiratory distress
 - o 267036007 – Shortness of breath/ Dyspnea
 - o 56018004 – Wheezing
- Negated ICD-9 equivalent 780.60 – Fever

Revised Definition:

(,^[;/]J20^,or,^[;/]J4[345]^,or,^[;/]J80^,or,^[;/]R06.0^,or,^[;/]R060^,or,^[;/]R06.02^,or,^[;/]R0602^,or,^[;/]466.0^,or,^[;/]4660[;/]^,or,^[;/]49[236][;/]^,or,^[;/]518.82^,or,^[;/]51882[;/]^,or,^[;/]786.0[579]^,or,^[;/]7860[579][;/]^,or,^[;/]10509002[;/]^,or,^[;/]49158009[;/]^,or,^[;/]17569003[;/]^,or,^[;/]789677001[;/]^,or,^[;/]195967001[;/]^,or,^[;/]373895009[;/]^,or,^[;/]56018004[;/]^,or,^acute
bronchitis^,or,^emphysema^,or,!COPD!,or,^chronic obstructive airway disease^,or,^chronic
obstructive lung disease^,or,^chronic obstructive pulmonary disease^,or,^[;/]J45^,or,^asthma^,or,^bronchasthma^,or,!RAD!,or,^reactive airway disease^,or,^[;/]J80^,or,^difficulty breath^,or,^breathing problem^,or,^chest tightness^,or,^chronic
cough^,or,^dyspnea^,or,^shortness of
breath^,or,(,^wheez^,andnot,(,^cough^,or,^cold^,or,^congestion^,)),andnot,(,^[;/]R50.9^,or,^[;/]R509^,or,^[;/]780.60^,or,^[;/]78060[;/]^,or,^febrile^,or,^fever^,or,^high temp^,))