Influenza Surveillance Report

2017–2018 Season

November 2018

California Department of Public Health

Center for Infectious Diseases

Division of Communicable Disease Control

Immunization Branch

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Notes: This report will primarily focus on influenza surveillance in California; however, information on other respiratory viruses is provided where data are available. The majority of data in this report cover the influenza season (October 1, 2017–May 19, 2018 [calendar weeks 2017-40 – 2018-20]); however, some data sources cover the period October 1, 2017– September 29, 2018 (calendar weeks 2017-40 – 2018-39). Data presented in this report are as of September 29, 2018; any deviations from this are noted where applicable.

Synopsis

Nationally, the 2017–2018 influenza season (October 1, 2017–May 19, 2018) was a high severity season with high levels of outpatient clinic and emergency department visits for influenza-like illness (ILI), high influenza-related hospitalization rates, and elevated and geographically widespread influenza activity across the country for an extended period. Nationally, ILI activity began increasing in November, reaching an extended period of high activity during January–February, and remaining elevated through March. Influenza A (H3N2) viruses predominated overall, but influenza B viruses predominated from March through May.[1,2] In California, influenza activity reached very high levels of severity. Very high levels of hospitalizations for pneumonia and influenza at Northern Kaiser Permanente facilities, influenza-coded deaths on death certificates, and outpatient visits for ILI, as well as a record number of influenza outbreaks were reported. Influenza activity in California began increasing in early December, peaking in late-December/early-January (Figure 1). This timing was similar to that seen during the 2016–2017 influenza season and earlier than the 2012–2013 through 2015–2016 influenza seasons in the state. In California, influenza A (H3N2) viruses predominated overall, but influenza B viruses predominated from mid-February through May.

Figure 1. Selected influenza surveillance parameters, California Department of Public Health, 2017–2018
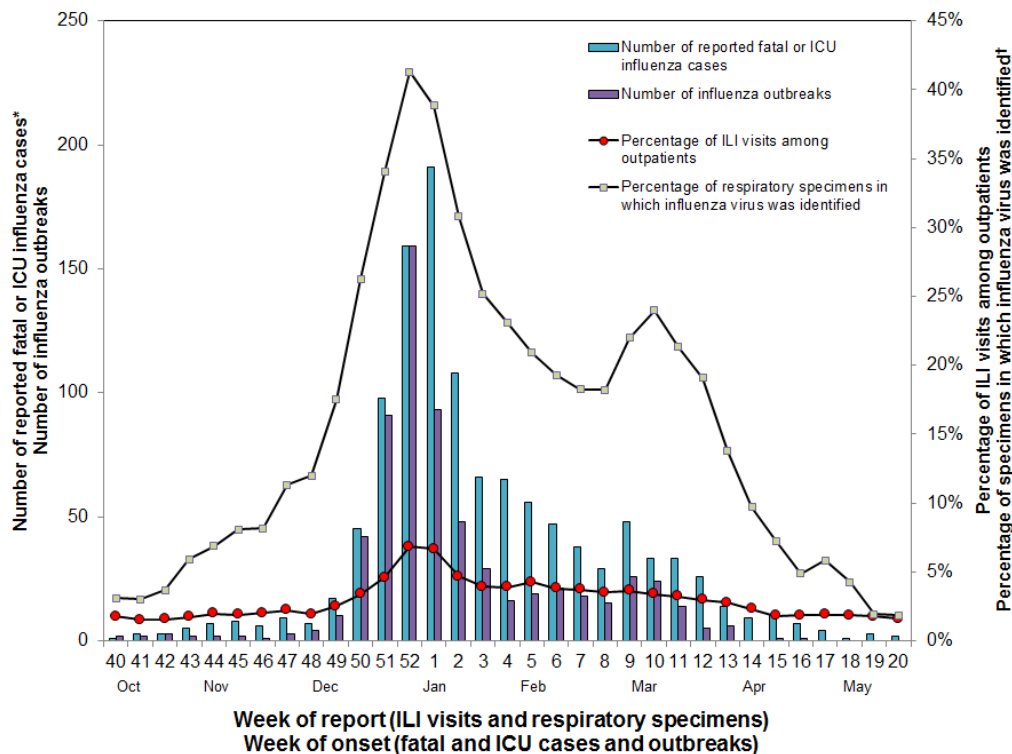
*Includes persons <65 years of age only
†Specimens tested at clinical sentinel laboratories only

The percentage of influenza-like illness (ILI) visits among outpatients and the percentage of laboratory detections for influenza at clinical sentinel laboratories peaked during the week ending December 30, 2017 (6.8% and 41.3%, respectively). The level of ILI activity was the highest seen since the 2009 influenza pandemic and the percentage of specimens testing positive for influenza exceeded that seen during the 2009 influenza pandemic. A total of 721 confirmed respiratory outbreaks were reported during the 2017–2018 season; 659 were associated with influenza. Among the 659 influenza-associated outbreaks, influenza A was the most commonly identified influenza virus. The majority of influenza-associated outbreaks occurred in residential healthcare facilities; however, outbreaks occurring in residential care facilities are more likely to be identified and reported to CDPH than other respiratory outbreaks.

Eighteen laboratory-confirmed influenza-associated pediatric deaths were reported to the California Department of Public Health (CDPH) during October 1, 2017–September 29, 2018. This number is within the range (5 [reported during the 2007–2008 season] to 37 [reported during the 2008–2009 season]) of past influenza seasons since fatal pediatric influenza surveillance began in 2003. During the 2017–2018 season, CDPH had 1,164 cases of influenza-associated severe illness or death reported among persons less than 65 years of age compared to 521 cases reported in 2016–2017. However, these data may be incomplete because reporting of non-fatal intensive care unit (ICU) cases is voluntary.

Surveillance Data

A. CDPH Virologic Surveillance

The CDPH obtains data on laboratory-confirmed influenza and other respiratory viruses from a number of laboratories throughout the state. These laboratories include the CDPH Viral and Rickettsial Disease Laboratory (VRDL) and 26 local public health laboratories, collectively known as the Respiratory Laboratory Network (RLN), and 26 clinical, academic, and hospital laboratories, which are referred to as clinical sentinel laboratories.

During the 2017–2018 influenza season, influenza A viruses were the most commonly identified influenza viruses identified by RLN and clinical sentinel laboratories, and influenza A (H3N2) was the predominant influenza strain circulating in California. The proportion of influenza B viruses identified by RLN and clinical sentinel laboratories began increasing in February and were more frequently identified than influenza A viruses during mid-February through May. These virologic surveillance data are similar to national findings.[1,2]

The proportion of specimens testing positive at clinical sentinel laboratories for all types of influenza first exceeded 10% – an indication that higher than normal levels of influenza virus were circulating – during the week ending November 25, 2017. The proportion of influenza-positive specimens peaked at 41.3% during the week ending December 30, 2017, and declined

to less than 10% during the week ending April 7, 2018. In contrast, national influenza activity peaked for five consecutive weeks during January 13–February 10 (range = 26.1%–26.9%).[1,2]

1. Respiratory Laboratory Network (RLN) Surveillance

The RLN laboratories offer polymerase chain reaction (PCR) testing for influenza A and influenza B, including influenza A subtyping and influenza B lineage typing, and some offer testing for respiratory syncytial virus (RSV), a common respiratory virus. RLN laboratories often receive specimens that have already tested positive for influenza at a clinical laboratory; therefore, the percentage of specimens testing positive for influenza at RLN laboratories is not an accurate indicator of influenza activity.

Of 12,767 specimens tested by RLN laboratories from October 1, 2017 through May 19, 2018, 7,033 (55.1%) were positive for influenza; of these, 5,038 (71.6%) were influenza A and 1,995 (28.4%) were influenza B (Table 1). Of the 5,038 positive influenza A specimens, 4,236 (84.1%) were A (H3N2), 615 (12.2%) were A (H1N1)pdm09, and 187 (3.7%) were not subtyped. Of the 1,995 positive influenza B specimens, 1,136 (56.9%) were B/Yamagata lineage, 166 (8.3%) were B/Victoria lineage, and 693 (34.7%) were not lineage typed. In addition to influenza testing, 2,831 specimens were tested for RSV by RLN laboratories; 351 (12.4%) were positive.

Table 1. RLN influenza and respiratory syncytial virus (RSV) surveillance results, October 1, 2017–May 19, 2018

	Total*		Northern CA		Central CA		Southern CA	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Specimens tested for influenza	**12,767**		**4,499**		**888**		**7,380**	
Positive for influenza	7,033	(55.1)[†]	1,962	(43.6)[†]	487	(54.8)[†]	4,584	(62.1)[†]
Influenza A	5,038	(71.6)[‡]	1,524	(77.7)[‡]	377	(77.4)[‡]	3,137	(68.4)[‡]
A (H1N1)pdm09	615	(12.2)[§]	218	(14.3)[§]	65	(17.2)[§]	332	(10.6)[§]
A (H3N2)	4,236	(84.1)[§]	1,206	(79.1)[§]	304	(80.6)[§]	2,726	(86.9)[§]
Subtyping not performed	187	(3.7)[§]	100	(6.6)[§]	8	(2.1)[§]	79	(2.5)[§]
Influenza B	1,995	(28.4)[‡]	438	(22.3)[‡]	110	(22.6)[‡]	1,447	(31.6)[‡]
Yamagata	1,136	(56.9)[¥]	122	(27.9)[¥]	20	(18.2)[¥]	994	(68.7)[¥]
Victoria	166	(8.3)[¥]	10	(2.3)[¥]	7	(6.4)[¥]	149	(10.3)[¥]
Lineage typing not performed	693	(34.7)[¥]	306	(69.9)[¥]	83	(75.5)[¥]	304	(21.0)[¥]
Specimens tested for RSV	**2,831**		**1,582**		**461**		**788**	
Positive for RSV	351	(12.4)	168	(10.6)	52	(11.3)	131	(16.6)

* Participating laboratories:
Statewide: CDPH Viral and Rickettsial Disease Laboratory
Northern California: Alameda, Contra Costa, Humboldt, Placer, Sacramento, San Francisco, San Mateo, Santa Clara, Shasta, Solano, and Sonoma county public health laboratories
Central California: Fresno, Monterey, San Joaquin, Stanislaus, and Tulare county public health laboratories
Southern California: Imperial, Long Beach, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, and Ventura county public health laboratories
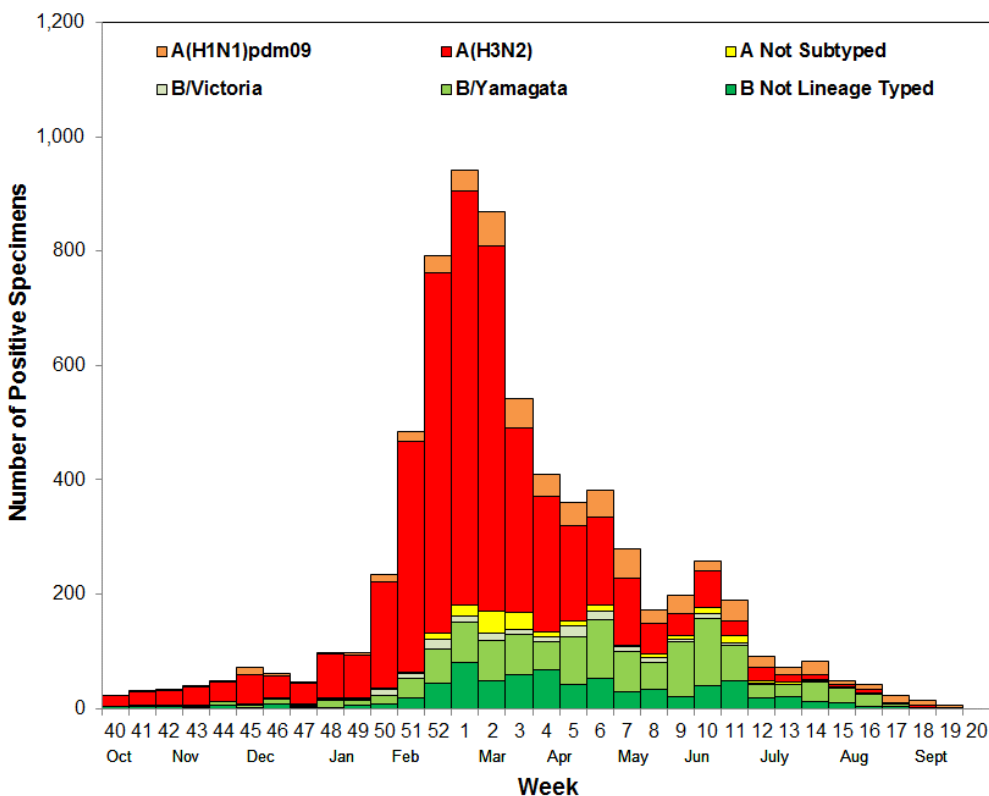† Percent is of the total specimens tested for influenza by PCR
‡ Percent is of the specimens positive for influenza
§ Percent is of the influenza A positive specimens
¥ Percent is of the influenza B positive specimens

Figure 2. Influenza positive specimens by type and subtype, Respiratory Laboratory Network Laboratories, 2017–2018

2. Clinical Sentinel Laboratory Surveillance

The clinical sentinel laboratories use various methods to test for influenza, including rapid test, direct fluorescent assay, viral culture, and PCR. Because clinical sentinel laboratory specimens submitted for influenza testing are arising from the healthcare setting, they are more likely to reflect influenza activity than specimens tested at RLN laboratories; however, many clinical laboratories do not perform influenza A subtyping or influenza B lineage typing.

From October 1, 2017 through May 19, 2018, clinical sentinel laboratories tested a total of 133,828 specimens for influenza, of which 27,495 (20.5%) were positive for influenza. Of the 27,495 specimens that tested positive, 16,351 (59.5%) were positive for influenza A and 11,144 (40.5%) were positive for influenza B (Table 2). In addition to influenza specimens, 108,038 specimens were tested for RSV by clinical sentinel laboratories; 10,113 (9.4%) were positive.

The overall level of influenza activity from sentinel clinical laboratories seen during the 2017–2018 season exceeded activity levels seen during the 2009 influenza pandemic, and the peak of activity during the 2017–2018 season was 1 to 7 weeks earlier than the previous four seasons (Figure 3). RSV activity occurred later than influenza activity, peaking during the week ending February 10, 2018 and was lower than activity during the 2016–2017 season (Figure 4).

Rhinoviruses and enteroviruses were the most frequently detected viruses among other tested respiratory viruses (Figure 5).

Table 2. Influenza and respiratory syncytial virus (RSV) detections in clinical sentinel laboratories*, October 1, 2017–May 19, 2018

	Total*		Northern CA		Central CA		Southern CA	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Influenza								
Specimens tested for influenza	**133,828**		**44,172**		**10,825**		**78,831**	
Positive for influenza	**27,495**	(20.5)†	**10,769**	(24.4)†	**2,846**	(26.3)†	**13,880**	(17.6)†
Influenza A	16,351	(59.5)‡	5,624	(52.2)‡	1,566	(55.0)‡	9,161	(66.0)‡
Influenza B	11,144	(40.5)‡	5,145	(47.8)‡	1,280	(45.0)‡	4,719	(34.0)‡
RSV								
Specimens tested for RSV	**108,038**		**39,940**		**8,462**		**59,636**	
Positive for RSV	10,113	(9.4)	3,881	(9.7)	1,115	(13.2)	5,117	(8.6)

* Number of participating laboratories by county:
Northern California: Alameda(1), Butte(1), and San Francisco(1). In addition, Northern California Kaiser
      Permanente has facilities in multiple counties within the Northern California region.
Central California: Madera(1). In addition, Northern California Kaiser Permanente has facilities in multiple counties
      within the Central California region.
Southern California: Imperial(5), Long Beach(1), Los Angeles(4), San Bernardino(1), and San Diego(8). In addition,
      Southern California Kaiser Permanente has facilities in multiple counties within the Southern California region.
† Percent is of the total specimens tested for influenza
‡ Percent is of the specimens positive for influenza

Figure 3. Percentage of specimens from which influenza was detected in clinical sentinel laboratories, 2013–2018*
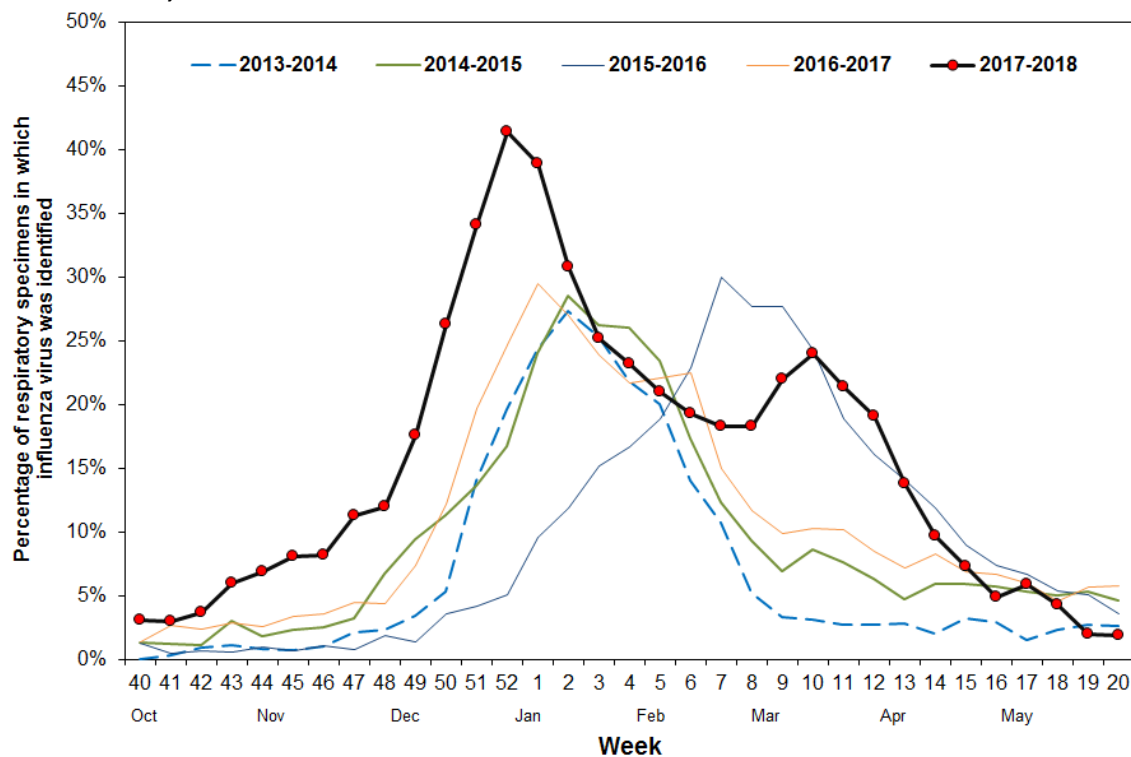

Note: The 2014–15 season contains a week 53. Data have been shifted so that week 1 aligns across years.

Figure 4. Percentage of specimens from which RSV was detected in clinical sentinel laboratories, 2013–2018
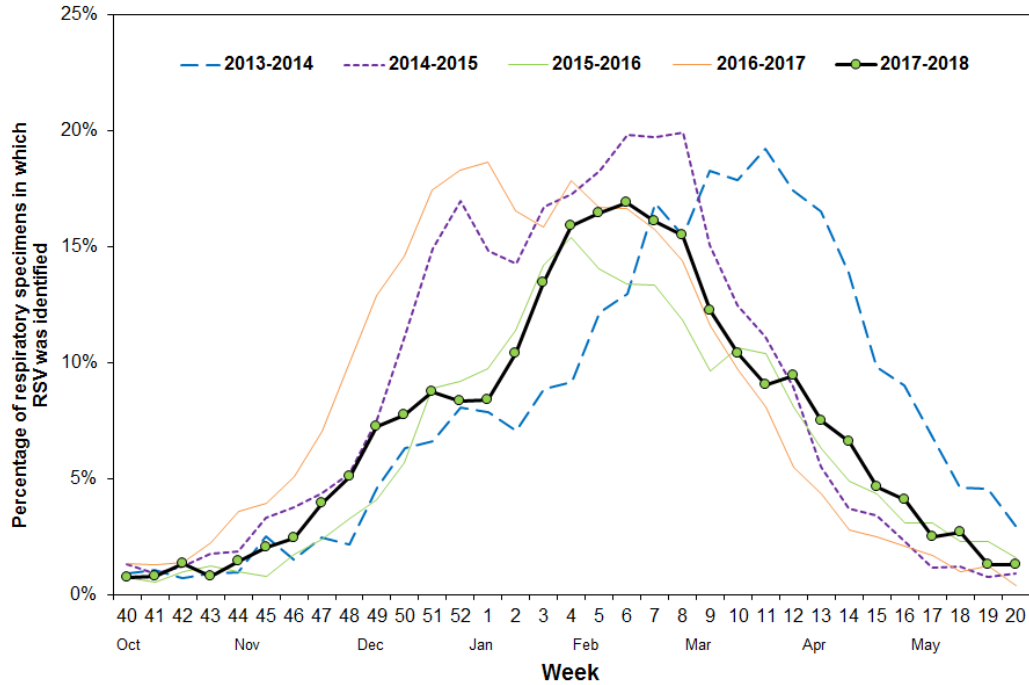
Note: The 2014–15 season contains a week 53. Data have been shifted so that week 1 aligns across years.

Figure 5. Percentage of specimens from which other respiratory viruses were detected in clinical sentinel laboratories, 2017–2018
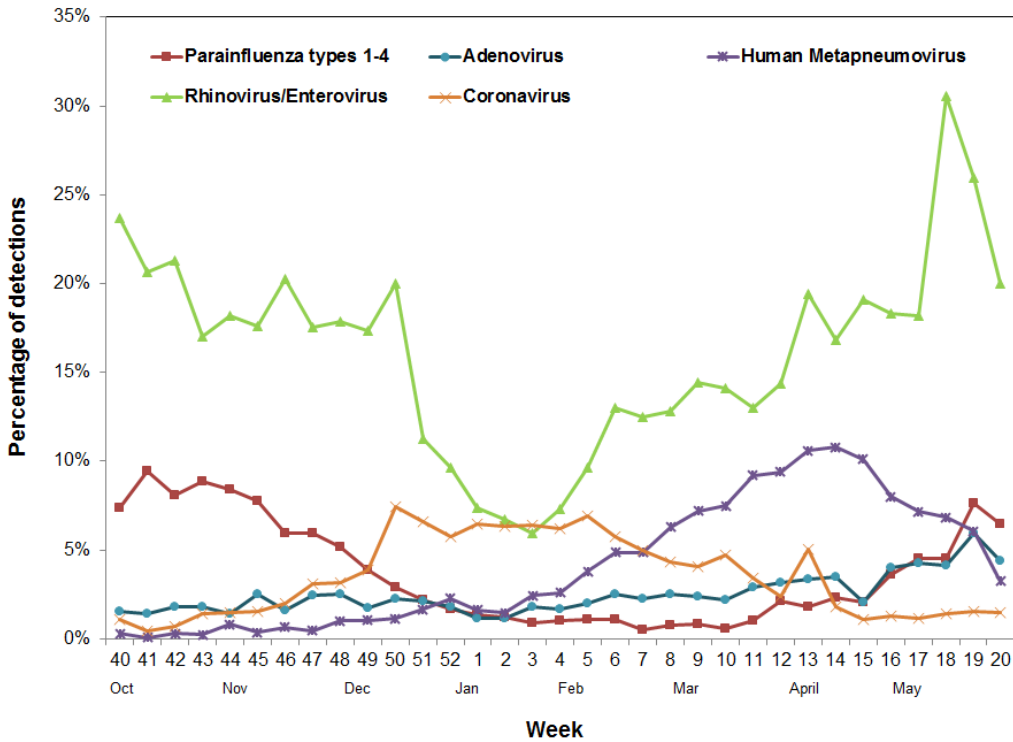
3. Influenza Virus Strain Characterization

A total of 169 influenza viruses isolated from influenza positive samples collected throughout California were antigenically characterized (strain typing) by the Centers for Disease Control and Prevention (CDC) during the 2017–2018 influenza season (Table 3). Forty-four of 44 (100%) A (H1N1)pdm09 viruses and 49 of 49 (100%) A (H3N2) viruses were characterized as A/Michigan/45/2015-LIKE (H1N1) and A/Hong Kong/4801/2014-LIKE (H3N2), respectively, the H1N1pdm09 and H3N2 components included in the 2017–2018 influenza vaccine for the Northern Hemisphere. Nationally, 99.9% of influenza A (H1N1)pdm09 viruses and 93.4% of influenza A (H3N2) viruses submitted to CDC from U.S. laboratories were antigenically similar to the influenza A components of the trivalent and quadrivalent vaccines.

Among influenza B viruses submitted to CDC from California, 21 of 24 (87.5%) B/Victoria lineage viruses were antigenically characterized as B/Brisbane/60/2008-LIKE (Victoria lineage), the influenza B component of the trivalent and quadrivalent influenza vaccines for the Northern Hemisphere. In addition, all 52 (100%) B/Yamagata lineage viruses were antigenically characterized as B/Phuket/3073/2013-LIKE (Yamagata lineage), the additional influenza B component included in the quadrivalent vaccine for the Northern Hemisphere. Nationally, 19.6% of influenza B/Victoria viruses and 100% of influenza B/Yamagata viruses submitted to CDC from U.S. laboratories were antigenically similar to the influenza B component(s) of the trivalent (B/Victoria only) and quadrivalent (B/Victoria and B/Yamagata) vaccines.

Table 3. Influenza virus antigenic characterization, 2017–2018 season

Influenza Subtype/Lineage	Vaccine Strain	California*	United States*
Influenza A (H1)pdm09	A/Michigan/45/2015-LIKE	44/44	735/736
Influenza A (H3)	A/Hong Kong/4801/2014-LIKE	49/49	612/655
Influenza B Victoria[†]	B/Brisbane/60/2008-LIKE	21/21	53/270
Influenza B Yamagata[‡]	B/Phuket/3073/2013-LIKE	52/52	824/824

* California data are for viruses isolated from specimens collected during October 1, 2017–April 2, 2018 and characterized through September 29, 2018; CDC data are for viruses characterized through May 19, 2018[1]

† The influenza B Victoria lineage virus is included in both the 2017–2018 trivalent and quadrivalent influenza vaccines

‡ The influenza B Yamagata lineage virus is included in only the 2017–2018 quadrivalent influenza vaccine

4. Antiviral Resistance Testing

The CDPH-VRDL monitors influenza viruses for antiviral resistance (AVR) using genetic and phenotypic analysis. All suitable selected influenza A (H1N1)pdm09, A (H3N2), and B positive samples collected throughout California are simultaneously assessed genetically, by whole genome sequencing, and phenotypically, by the functional neuraminidase inhibition (NI) assay. The NI assay is performed on viral isolates and is the preferred method for the detection of viral resistance to the neuraminidase inhibitor (NAI) class drugs (including oseltamivir, zanamivir, and peramivir) caused by established (e.g., H275Y) or novel mutations. Furthermore, AVR surveillance is also performed on additional influenza A (H1N1)pdm09 and A (H3N2) positive

clinical specimens by using the high throughput pyrosequencing assay to detect single mutations known to confer NAI resistance. Of the 294 influenza specimens tested by the CDPH-VRDL during the 2017–2018 influenza season, two influenza A (H1N1)pdm09 viruses were found to be resistant to NAIs (Table 4).

Table 4. Number of specimens tested for antiviral resistance, California, 2017–2018 season

	Neuraminidase Inhibitor Resistance
Influenza A (H1N1)pdm09	2/97
Influenza A (H3N2)	0/119
Influenza B	0/78

CDC also performs antiviral resistance testing as part of its routine national surveillance. CDC tested 4,619 influenza viruses from throughout the United States, including California, collected since October 1, 2017, for resistance to the influenza neuraminidase inhibitor antiviral medications recommended for use against seasonal influenza (oseltamivir, peramivir, and zanamivir). Among 1,147 influenza A (H1N1)pdm09 viruses tested for oseltamivir and peramivir susceptibility, 11 (1.0%) were resistant to both drugs and contain a known marker of resistance in the neuraminidase gene segment (H275Y). Among 786 influenza A (H1N1)pdm09 viruses also tested for zanamivir susceptibility, no resistant viruses were detected. All 2,354 influenza A (H3N2) viruses tested for oseltamivir and zanamivir susceptibility were susceptible to both medications. No peramivir-resistant viruses were detected among 1,248 A (H3N2) viruses tested. All 1,118 influenza B viruses tested were susceptible to all three medications.[1]

5. Novel Influenza A Viruses
Six variant influenza A (H1N2v) viruses were detected in California. All case-patients had onsets during the weeks ending July 28, 2018 and August 4, 2018. Five of the six patients reported exposure to swine at an agricultural event in the week prior to their illness onset, and one patient reported no contact with swine and no attendance at an agricultural event. It is possible that limited person-to-person transmission occurred; however, no ongoing person-to-person transmission was identified. None of the patients were hospitalized and there were no deaths; all recovered from their illnesses.

When an influenza virus that normally circulates in swine (but not people) is detected in a person, it is called a "variant influenza virus." Human infections with variant influenza viruses are not common and person-to-person transmission of these viruses is rare. For more information about variant influenza virus infections, please visit the Centers for Disease Control and Prevention's Key Facts about Human Infections with Variant Viruses website (https://www.cdc.gov/flu/swineflu/keyfacts-variant.htm).

B. Case-Based Surveillance

1. Influenza-associated Severe Illness and Mortality in Californians <65 Years of Age

Laboratory-confirmed influenza-associated deaths among patients under 65 years of age are reportable in California [Title 17, California Code of Regulations (CCR) §2500]. Since the A (H1N1)pdm09 influenza pandemic, local health jurisdictions (LHJs) have also voluntarily reported to the CDPH laboratory-confirmed influenza-associated hospitalizations requiring intensive care unit (ICU) admission for patients less than 65 years of age.

Epidemiologic Curve of ICU and Fatal Cases <65 Years of Age
During the 2017–2018 influenza season, CDPH received 1,164 reports of influenza-associated severe illness (ICU admissions) or deaths among persons less than 65 years of age; 1,158 (99.5%) had onset during weeks 40–20 (October 1, 2017 through May 19, 2018) and 6 (0.5%) had onset during the summer months (May 20, 2018 through September 29, 2018). Of the 1,164 influenza-associated severe and fatal cases reported, 828 (71.1%) were non-fatal ICU cases and 336 (28.9%) were fatal cases. Figure 6 shows the number of fatal and non-fatal ICU cases by week of onset during 2017–2018. Influenza-associated death case counts by local health jurisdiction for the 2013–2014 through the 2017–2018 influenza season can be found in the Appendix.

Figure 6. Number of influenza-associated fatal and non-fatal ICU cases (<65 years of age) reported to the California Department of Public Health, by week of symptom onset, October 1, 2017–September 29, 2018
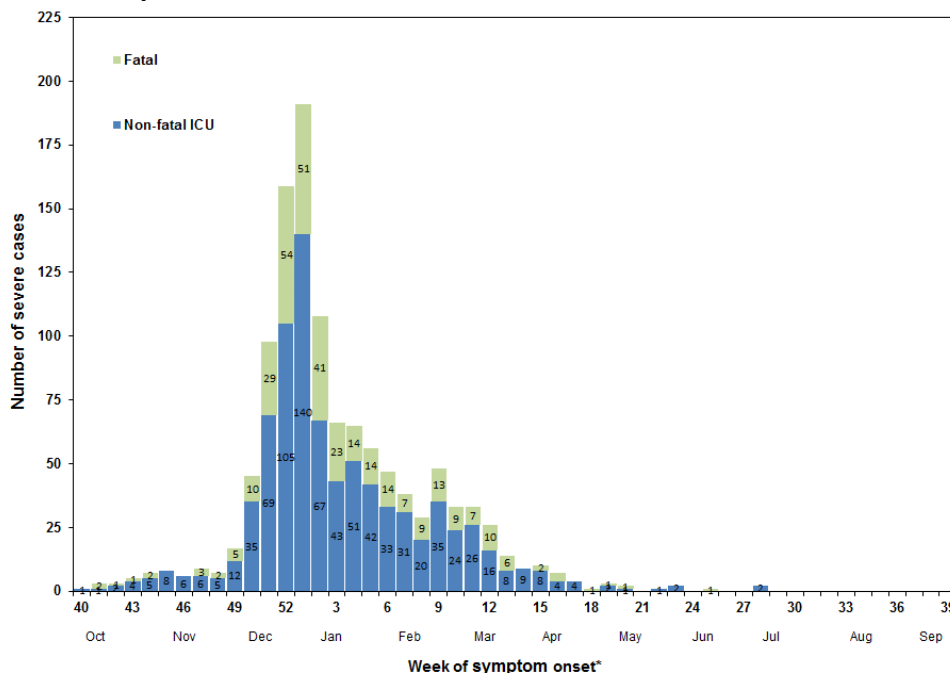
* If onset date was not available, then the earliest known date associated with the illness was used.

Demographic Characteristics and Clinical Features of ICU and Fatal Cases <65 Years of Age
The median age of onset for the 1,164 patients who had influenza-associated severe or fatal illness during the 2017–2018 season was 51 years (range: 1 week–64 years); 619 (53.2%) were male (Table 5). Fatal cases (median age: 55 years; range: 11 months–64 years) were significantly older than non-fatal ICU cases (median age: 48 years; range: 1 week–64 years) [p<0.001]. The majority of the 1,164 influenza-associated severe or fatal cases reported during the 2017–2018 influenza season occurred among adults aged 18–64 years of age (952; 81.8%). Pediatric cases under the age of 18 years accounted for 18.2% (n=212) of the severe and fatal cases.

The CDPH case-based surveillance data should be interpreted with caution due to the following limitations: exclusion of cases 65 years of age and older, voluntary reporting of ICU cases, differing degrees of participation by the LHJs, and biases in testing practices (e.g., specimens may not be available for influenza testing). These data are also considered provisional as some cases may still be under investigation.

Table 5. Demographic characteristics of non-fatal ICU and fatal cases of laboratory-confirmed influenza reported to the California Department of Public Health, October 1, 2017–September 29, 2018

	Non-fatal ICU cases* No. (%)	Fatal cases No. (%)
Total	828	336
Sex		
Male	441 (53.3)	178 (53.0)
Median age, in years	48	55
Age group		
0–4	107 (12.9)	6 (1.8)
5–17	87 (10.5)	12 (3.6)
18–49	239 (28.9)	83 (24.7)
50–64	395 (47.7)	235 (69.9)

* Reporting of influenza-associated ICU admissions is voluntary and might not be complete for all local health jurisdictions.
ICU – intensive care unit

Information on underlying medical conditions, including those conditions defined by the Advisory Committee for Immunization Practices (ACIP) as being associated with severe influenza, was collected for severely ill and fatal influenza cases.[3] The most frequently reported underlying medical conditions among adults aged 18–64 years with available information were metabolic disease (e.g., diabetes mellitus, renal disease; 436/671; 65.0%), chronic lung disease (e.g., asthma, chronic obstructive pulmonary disease; 371/651; 57.0%), and cardiac disease (e.g., coronary artery disease; 303/627; 48.3%) [Figure 7]. There were three pregnant woman among the influenza-associated ICU admissions.

Among pediatric patients with available information, the most frequently reported underlying medical condition was chronic lung disease (71/136; 52.2%); 34 (47.9%) of the 71 children with

chronic lung disease had asthma. Other frequently reported underlying medical conditions among pediatric patients include neurological disorders (e.g., seizure disorder, cerebral palsy; 53/138; 38.4%), gastrointestinal disease (e.g., gastroesophageal reflux, etc.; 33/117; 28.2%), and cardiac disease (32/133; 24.1%).

Seventy-three (35.4%) of the pediatric patients and 47 (5.2%) of the adult patients with information available were reported to be previously healthy; however, 59 (80.8%) of the 73 previously healthy children were <5 years of age, which is associated with an increased risk of developing influenza-related complications even in the absence of other underlying medical conditions.

Influenza vaccination information was available for 455 (47.8%) of the 952 adult cases reported with severe or fatal influenza; 211 (46.4%) received the 2017–2018 influenza vaccine. One hundred twenty (64.2%) of the 187 reported pediatric cases >6 months of age had influenza vaccination information available; 61 (50.8%) received the 2017–2018 influenza vaccine.

Figure 7. Selected underlying medical conditions in non-fatal ICU and fatal cases of laboratory-confirmed influenza reported to the California Department of Public Health, October 1, 2017–September 29, 2018
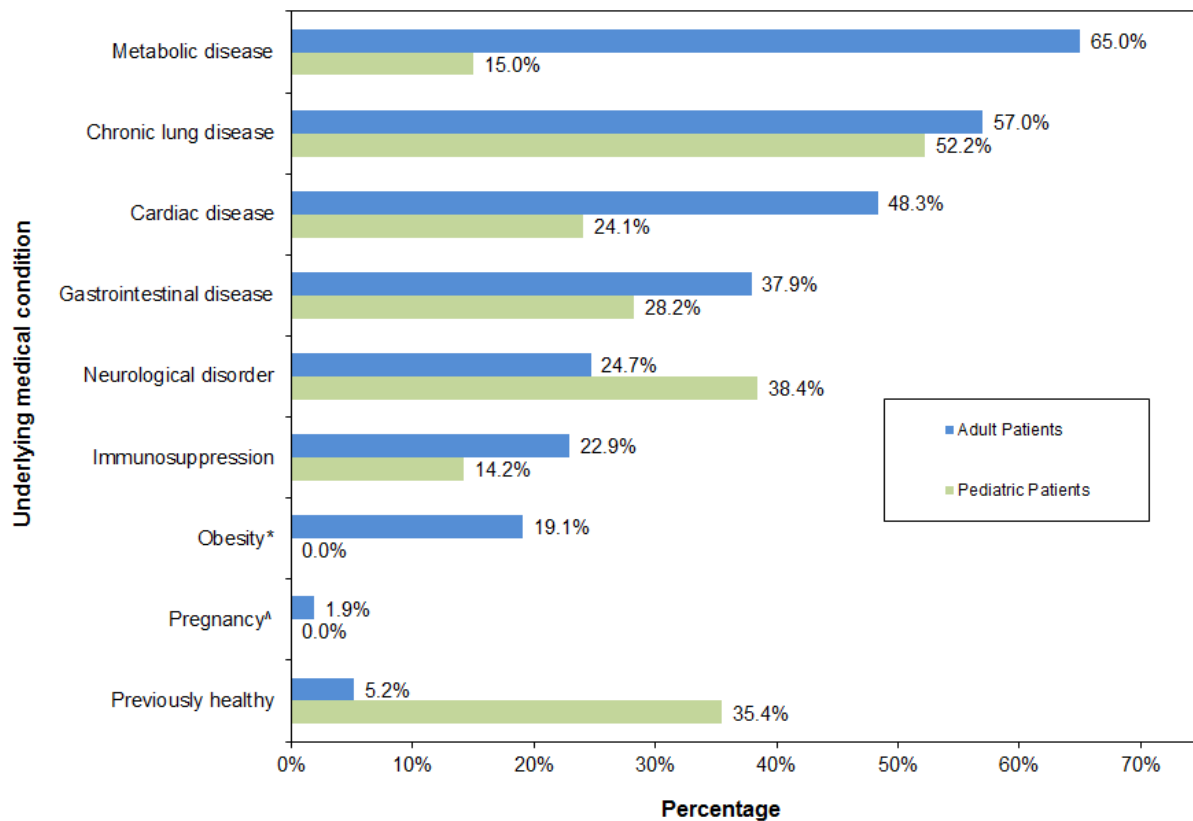
* Excludes pediatric patients <2 years of age and pregnant women
^ Among females 12–49 years of age

Influenza Types and Subtypes

Of the 1,164 severely ill and fatal influenza cases reported, 788 (67.7%) tested positive for influenza A, 366 (31.4%) tested positive influenza B, two (0.2%) tested positive for influenza A and B, and eight (0.7%) tested positive for influenza, but the influenza type was not known (Table 5). Of the 788 influenza A infections, 235 (29.8%) were A (H3N2), 72 (9.1%) were A (H1N1)pdm09, one (0.1%) was A (H3N2) and A (H1N1)pdm09, and 480 (60.9%) were not subtyped. Of the 366 influenza B infections, 11 (3.0%) were B/Yamagata lineage, 6 (1.6%) were B/Victoria lineage, and 349 (95.4%) were not lineage-typed. Influenza subtype and lineage type were not known for the influenza A and B co-infections.

Table 6. Influenza subtyping and lineage typing among laboratory-confirmed influenza non-fatal ICU and fatal cases reported to the California Department of Public Health, October 1, 2017–September 29, 2018

	Total	
	No.	(%)
Influenza A	**788**	**(67.7)***
A (H1N1)pdm09	72	(9.1)[†]
A (H3N2)	235	(29.8)[†]
A (H1N1)pdm09 and A (H3N2)	1	(0.1)[†]
Subtyping not performed	480	(60.9)[†]
Influenza B	**366**	**(31.4)***
Yamagata	11	(3.0)[§]
Victoria	6	(1.6)[§]
Lineage typing not performed	349	(95.4)
Influenza A and B	**2**	**(0.2)***
Flu type unknown	**8**	**(0.7)***

* Percent of all influenza positive patients
[†] Percent of influenza A positive specimens
[§] Percent of influenza B positive specimens

2. California Emerging Infections Program Data: Influenza-associated Hospitalizations

The California Emerging Infections Program (CEIP), Influenza Surveillance Network (FluSurv-NET) conducts population-based surveillance for laboratory-confirmed influenza-associated hospitalizations in all ages in Alameda, Contra Costa and San Francisco counties. FluSurv-NET is a national network which covers over 70 counties in the 10 Emerging Infections Program (EIP) states (CA, CO, CT, GA, MD, MN, NM, NY, OR, and TN) and three additional states (MI, OH, and UT). CEIP data for the 2017–2018 influenza season were finalized on October 29, 2018.

During the 2017–2018 season, the incidence of influenza-associated hospitalizations per 100,000 population began increasing in mid-December and peaked during the week ending January 6, 2018 with an incidence of 20.4 influenza hospitalizations per 100,000 population (Figure 8). This rate was substantially higher than the peak rate during the 2015–2016 and 2016–2017 influenza seasons (2.5 and 12.2 influenza hospitalizations per 100,000,

respectively). Of the 4,159 patients hospitalized in the three counties monitored by CEIP for influenza 2,627 (63.2%) had influenza A infections, 1,522 (36.6%) had influenza B infections, and 7 (0.2%) had influenza A and B co-infections. Three patients had an influenza infection, but the influenza type was not known. The highest cumulative rate of hospitalization was among adults aged >64 years, followed by the 50–64 year and 0–4 year age groups (Figure 9). Patients >64 years of age accounted for 67.5% of the total reported hospitalized cases.

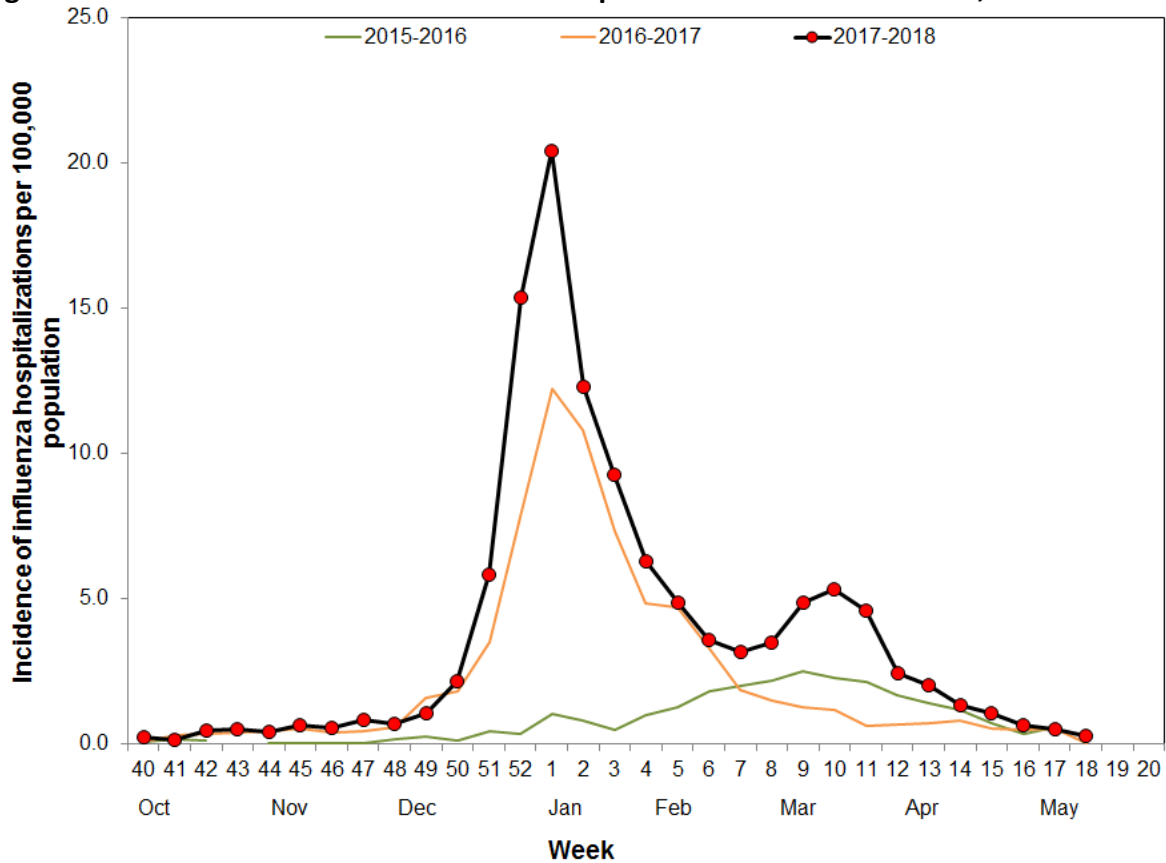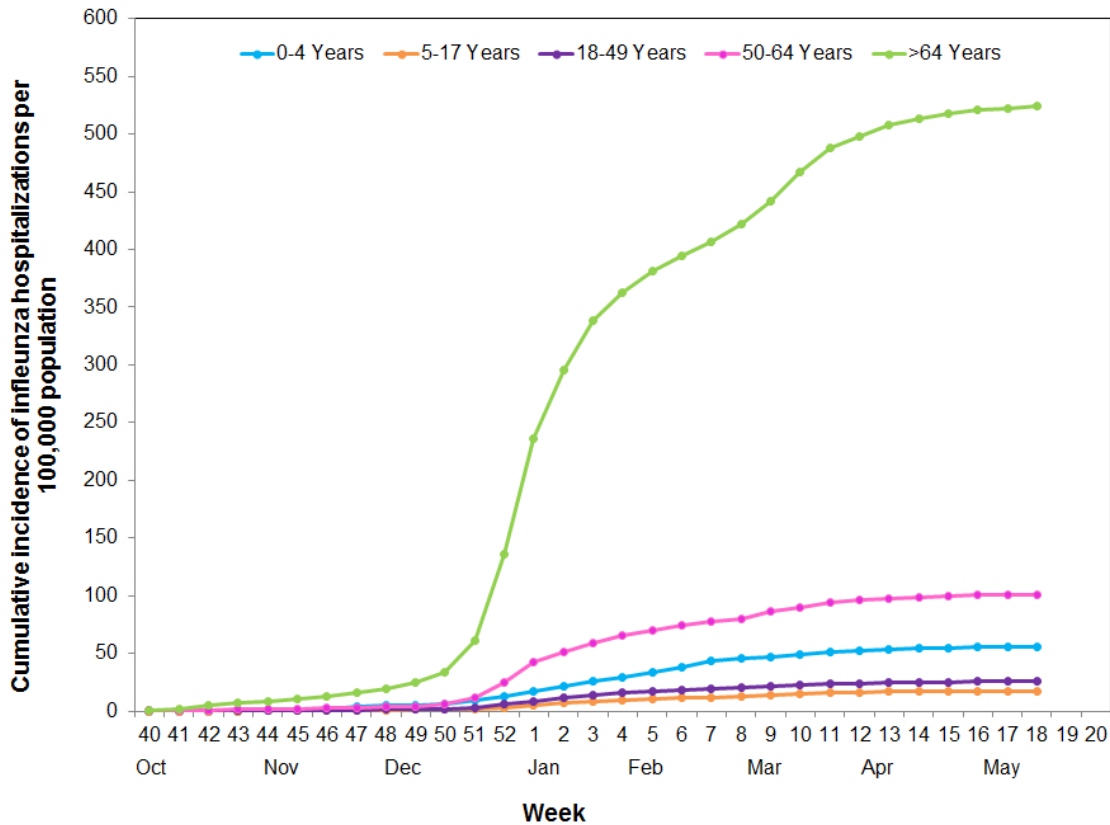**Figure 8. Incidence of influenza-associated hospitalizations in CEIP counties, 2015–2018**

Figure 9. Cumulative incidence of influenza hospitalizations in CEIP counties by age group, 2017–2018

## C. Syndromic Surveillance

1. Influenza-like Illness Outpatient Surveillance (Sentinel Providers)

In collaboration with CDC, the CDPH works with volunteer sentinel providers throughout the state to conduct year-round surveillance for ILI in outpatients. Sentinel providers may be individual practitioners or represent whole healthcare systems in a variety of outpatient settings including, but not limited to, hospital outpatient clinics, emergency departments, and student health services. Sentinel providers report on a weekly basis the number of patients with ILI and the total number of patients seen for any reason. Influenza-like illness is defined as any illness with (1) fever (≥100°F or 37.8°C) and (2) cough and/or sore throat, in the absence of a known cause other than influenza.

In California, 122 sentinel providers reported ILI activity on a regular basis (i.e. at least 17 of the 33 weeks from October 1, 2017 to May 19, 2018). There was minimal ILI activity until early December, when sentinel providers began reporting increases in patients with ILI (Figure 10). Influenza-like illness activity peaked at 6.8% during the week ending December 30, 2017 and remained elevated through early April, returning to seasonal baseline levels during mid-April.

The percentage of visits for ILI exceeded two standard deviations above baseline levels between the weeks ending December 9, 2017 and April 7, 2018.

Figure 10. Percentage of influenza-like illness visits among patients seen by California Sentinel Providers, 2013–2018*
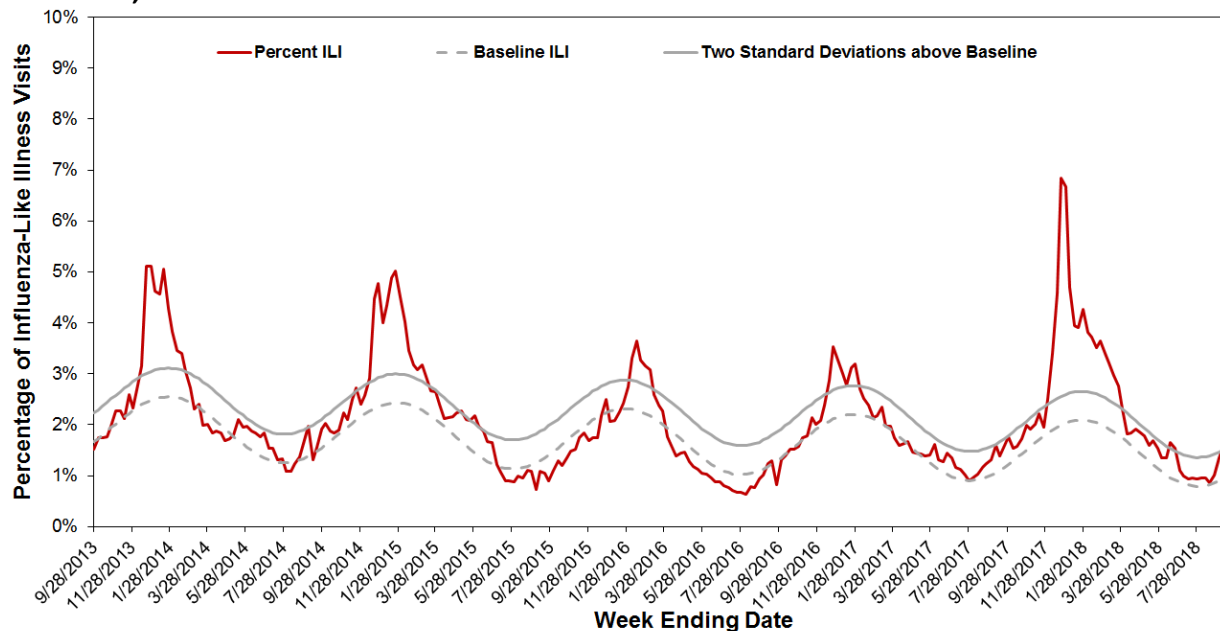
* The seasonal baseline was calculated using a regression model applied to data from the previous five years. Two standard deviations above the seasonal baseline is the point at which the observed percentage of ILI is significantly higher than would be expected at that time of the year.

Sentinel providers voluntarily submit specimens from patients with ILI to the CDPH-VRDL for influenza testing. Many of these specimens are sent to CDC for further characterization, providing important information about what influenza virus strains are circulating in the community. From October 1, 2017 through May 19, 2018, sentinel providers submitted 268 respiratory specimens; 135 (50.4%) were positive for influenza. Of these, 72 (53.3%) were influenza A and 63 (46.7%) were influenza B. Of the 72 positive influenza A specimens, 59 (81.9%) were A (H3N2) and 13 (18.1%) were A (H1N1)pdm09. Of the 63 positive influenza B positive specimens, 51 (81.0%) were B Yamagata, 11 (17.5%) were B Victoria, and one (1.6%) was not lineage-typed. The number of specimens submitted by sentinel providers that tested positive for influenza peaked during the week ending February 3, 2018 coinciding with the secondary peak in ILI activity (Figure 11). The primary peak in ILI activity during the week ending December 30, 2017 coincided with a drop in submitted specimens, which was likely due to the Christmas and New Year's holidays.

Figure 11. Sentinel Provider specimens tested by week of collection and influenza result, and percentage of influenza-like illness visits by week of visit, October 1, 2017–May 19, 2018
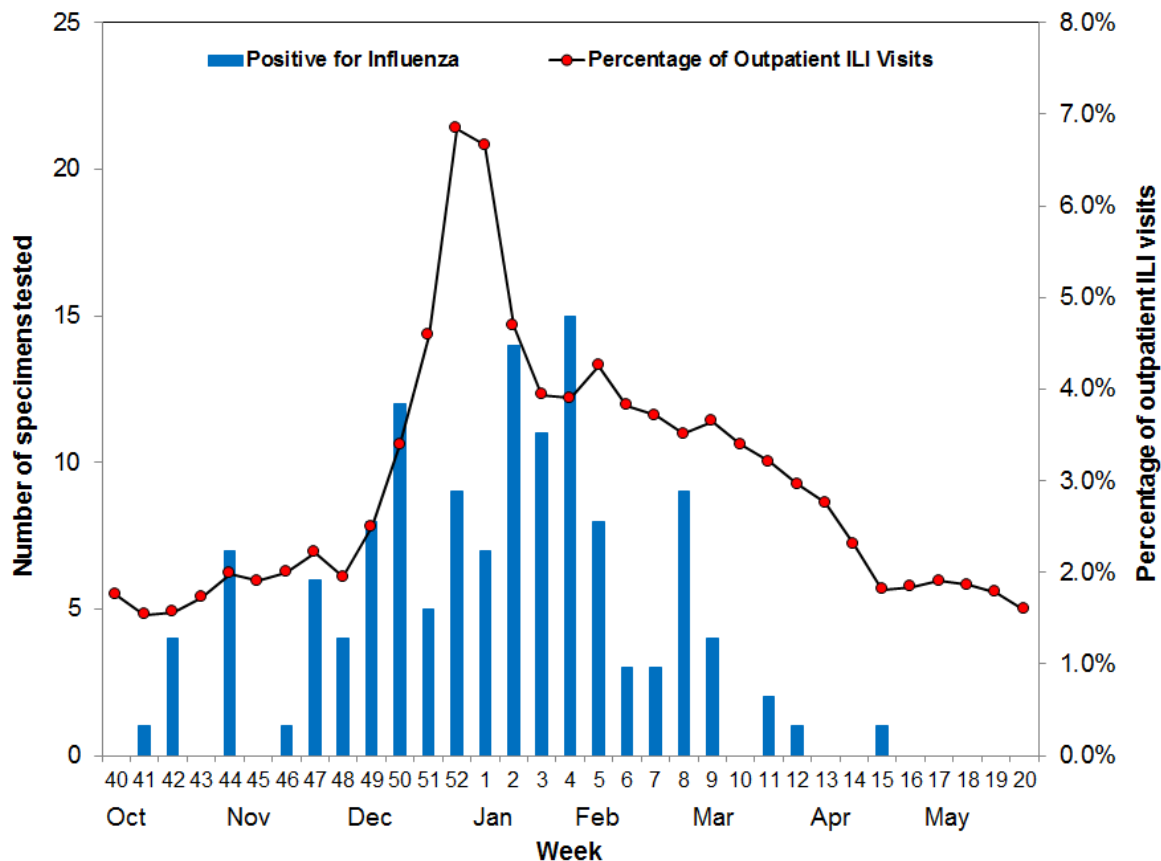

2. Kaiser Permanente Northern California Pneumonia and Influenza Admission Data

The CDPH collaborates with Northern California Kaiser Permanente to monitor trends in pneumonia and influenza-related hospitalizations. Patients with admission diagnoses of "flu," "pneumonia," or "influenza" are defined as pneumonia and influenza (P&I) admissions. The number of P&I admissions is divided by the total number of hospital admissions occurring in the same time period to estimate the percentage of P&I admissions. Admissions for pregnancy, labor and delivery, birth, and outpatient procedures are excluded from the denominator.

During the 2017–2018 influenza season, the percentage of P&I admissions in Northern California Kaiser Permanente hospitals began increasing in mid-December, peaking at 14.2% during the week ending January 6, 2018. This was the highest percentage of P&I admissions reported since the CPDH collaboration with Northern California Kaiser Permanente began in 2006. The percentage of P&I admissions remained elevated through early April. The percentage of P&I admissions exceeded two standard deviations above baseline levels between the weeks ending December 16, 2017 and April 7, 2018.

Figure 12. Percentage of pneumonia and influenza admissions in Northern California Kaiser Permanente hospitals, 2013–2018*
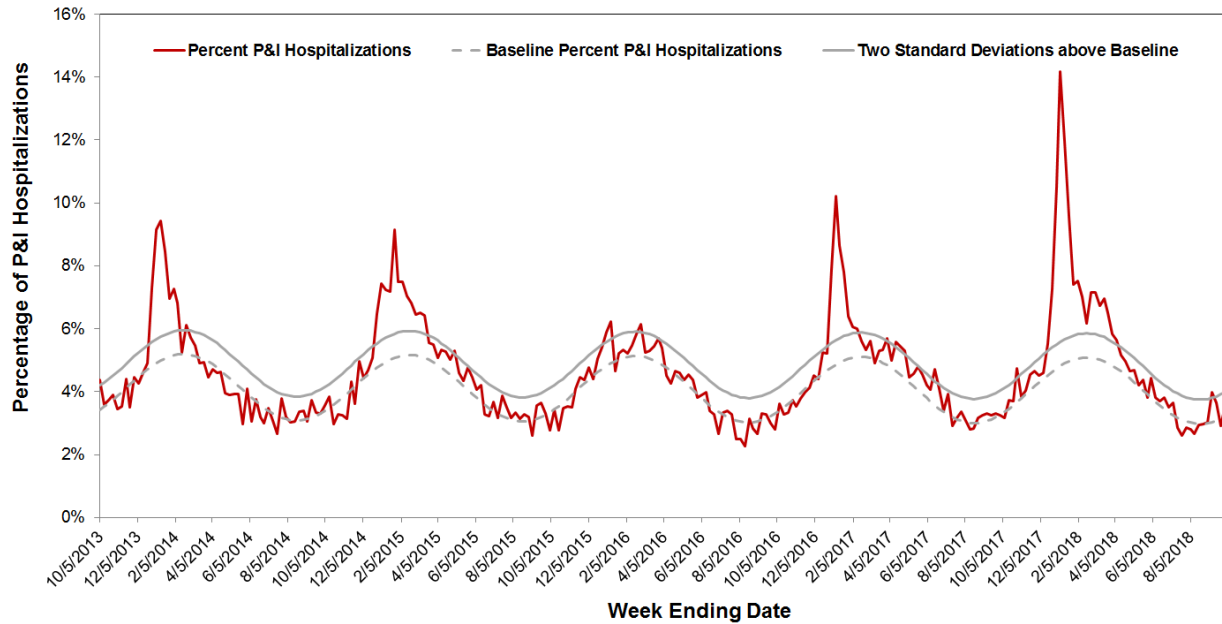

* The seasonal baseline was calculated using a regression model applied to data from the previous five years. Two standard deviations above the seasonal baseline is the point at which the observed percentage of pneumonia and influenza hospitalizations in Kaiser Permanente hospitals in Northern California is significantly higher than would be expected at that time of the year.

During October 1, 2017–September 29, 2018, the majority of hospitalizations due to pneumonia and influenza did not result in intensive care unit (ICU) admission or death; however, 1301 ICU and 640 deaths occurred among persons with P&I admission diagnoses (Figure 12a). The majority of P&I admissions occurred among person ≥65 years of age across all severity categories, especially among deaths (Figure 12b). Please note pneumonia and influenza admissions serve as a proxy for influenza activity but do not necessarily represent laboratory-confirmed influenza infections.

Figure 12. Number (a) and age group distribution (b) of non-ICU admissions, ICU admissions, and Deaths associated with P&I Admissions in Kaiser Permanente Northern California Hospitals, October 1, 2017–September 29, 2018

(a)
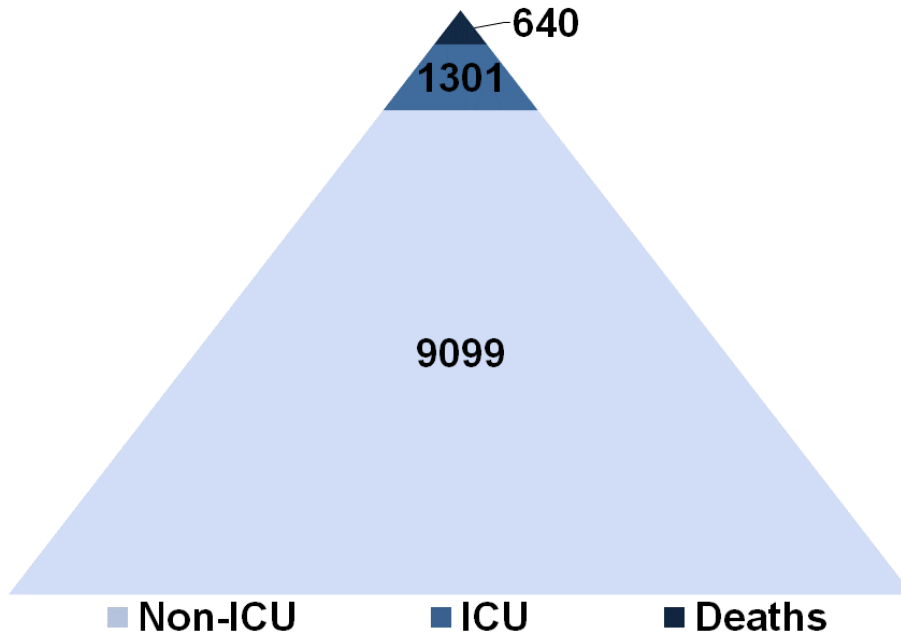
(b)
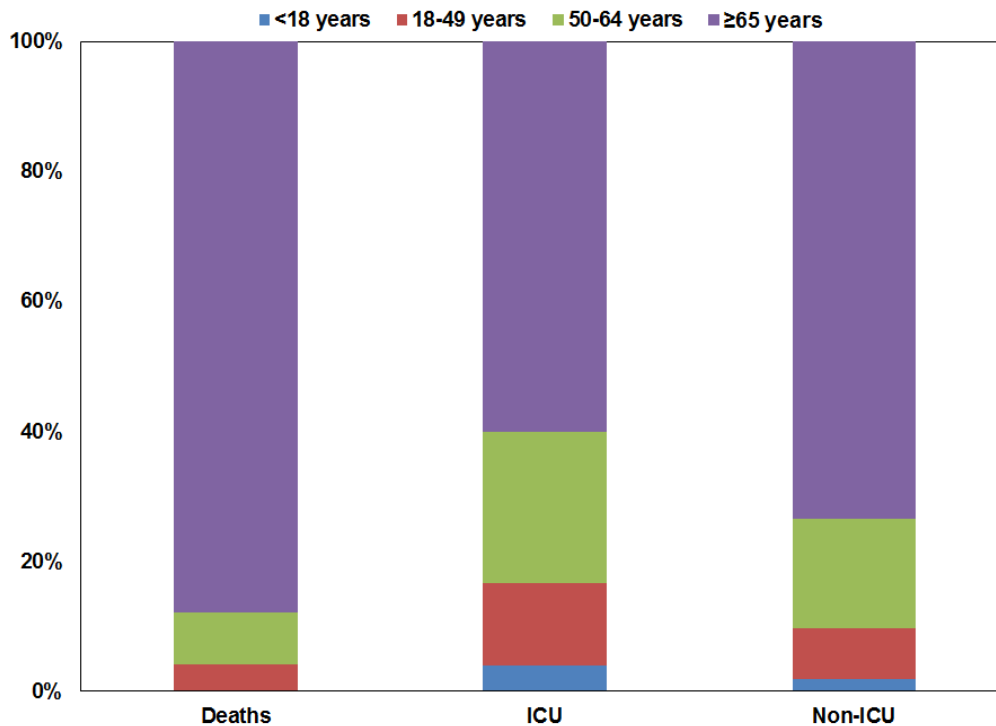
3. Influenza Mortality Surveillance from Death Certificates

Deaths occurring in California among residents who had influenza noted in any cause of death field on the death certificate (influenza specified in a text cause of death field or an influenza ICD-10 code in a coded cause of death field) are defined as influenza-coded deaths. The percentage of influenza-coded deaths is calculated by dividing the number of influenza-coded deaths by the total number of all cause deaths during the same period. Influenza-coded deaths are not necessarily laboratory-confirmed and are an underestimate of all influenza-associated deaths.

During October 1, 2017–September 29, 2018, 1,690 influenza-coded deaths were identified (Figure 13). The percentage of influenza-coded deaths began increasing in mid-December, peaking at 4.0% during the week ending January 13, 2018. This was the highest percentage of influenza-coded deaths reported since comparable data became available for analysis (Table 5). The percentage of influenza-coded deaths remained elevated through mid-April (Figure 14).

Figure 13. Number of Influenza-Coded Deaths Identified from Death Certificates by Week of Death, October 1, 2017–September 29, 2018
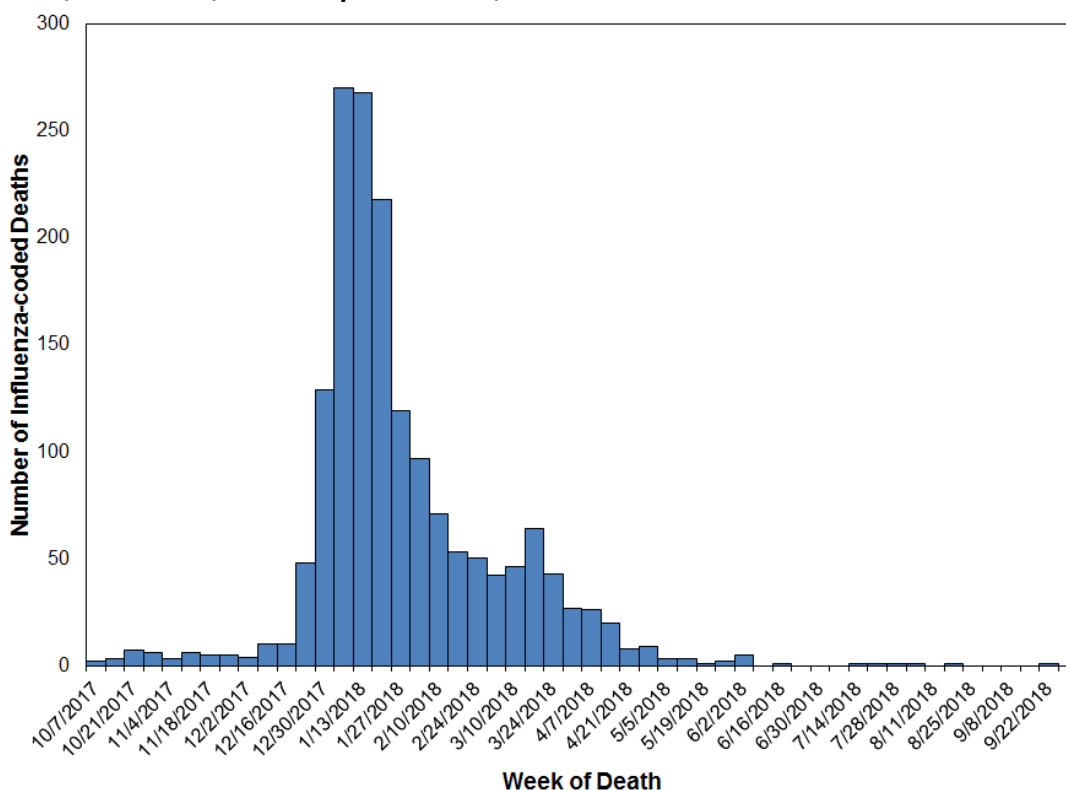
Table 5. Number and Percentage of Influenza-coded Deaths Occurring in California among California Residents, 2013–2014 through 2017–2018 Influenza Seasons

Influenza Season*	Total Number of Influenza-coded Deaths	Peak Percentage of Influenza-coded Deaths
2013–2014	448[†]	1.4%
2014–2015	343	0.9%
2015–2016	326	0.7%
2016–2017	579	1.2%
2017–2018	1,690	4.0%

* 2013–2014 influenza season: September 29, 2013–September 27, 2014; influenza A (H1N1)pdm09 predominant season
2014–2015 influenza season: September 28, 2014–October 3, 2015; influenza A (H3N2) predominant season
2015–2016 influenza season: October 4, 2015–October 1, 2016; mixed influenza A and influenza B season
2016–2017 influenza season: October 2, 2016–September 30, 2017; influenza A (H3N2) predominant season
2017–2018 influenza season: October 1, 2017–September 29, 2018; influenza A (H3N2) predominant season
[†] Data not available prior to January 1, 2014, so any influenza-coded deaths that occurred during September 29–December 31, 2013 are not included

Figure 14. Percentage of Influenza-coded Deaths Occurring in California among California Residents, 2013–2018*
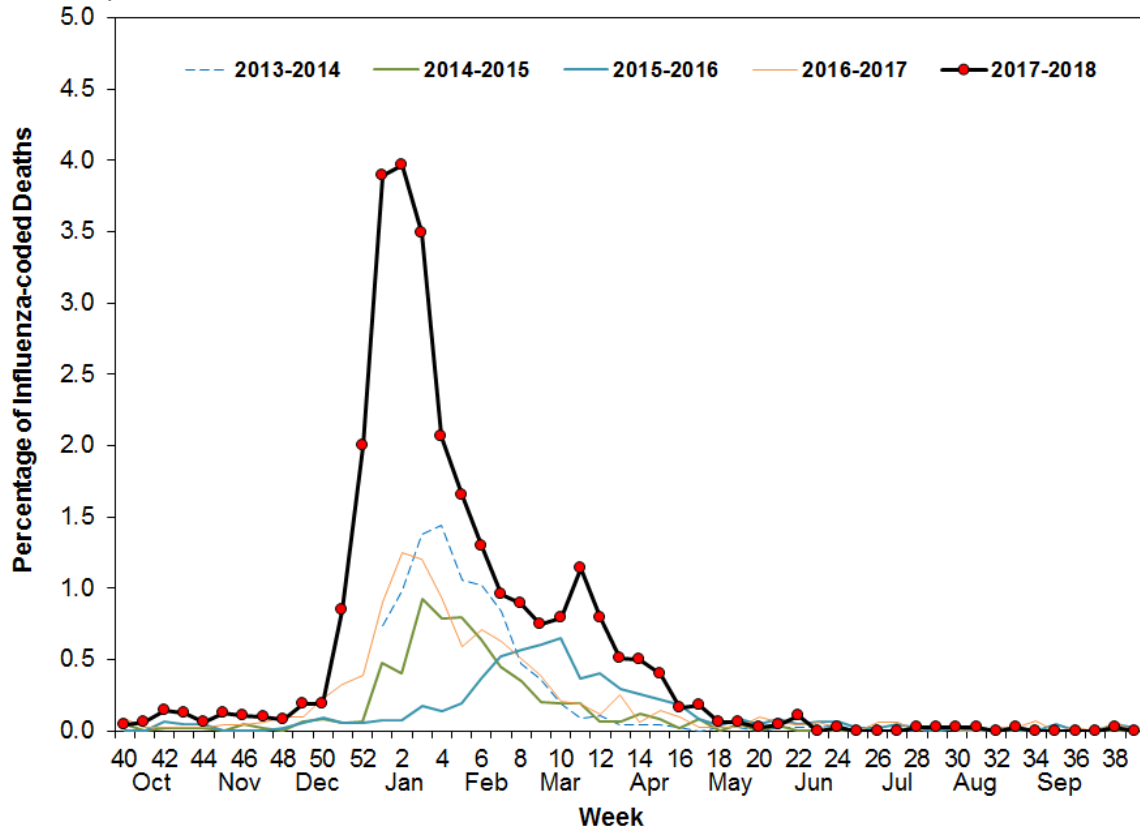
Note: The 2014–15 season contains a week 53. Data have been shifted so that week 1 aligns across years.

* Data not available prior to January 1, 2014.

The majority of deaths during the 2017–2018 influenza season occurred among persons 65 years of age and older, which is consistent with other influenza A (H3N2) predominant influenza seasons, such as the 2014–2015 and 2016–2017 seasons (Figure 15).

Figure 15. Age Distribution of Influenza-coded Deaths Occurring in California among California Residents, 2013–2014 Season through 2017–2018 Seasons
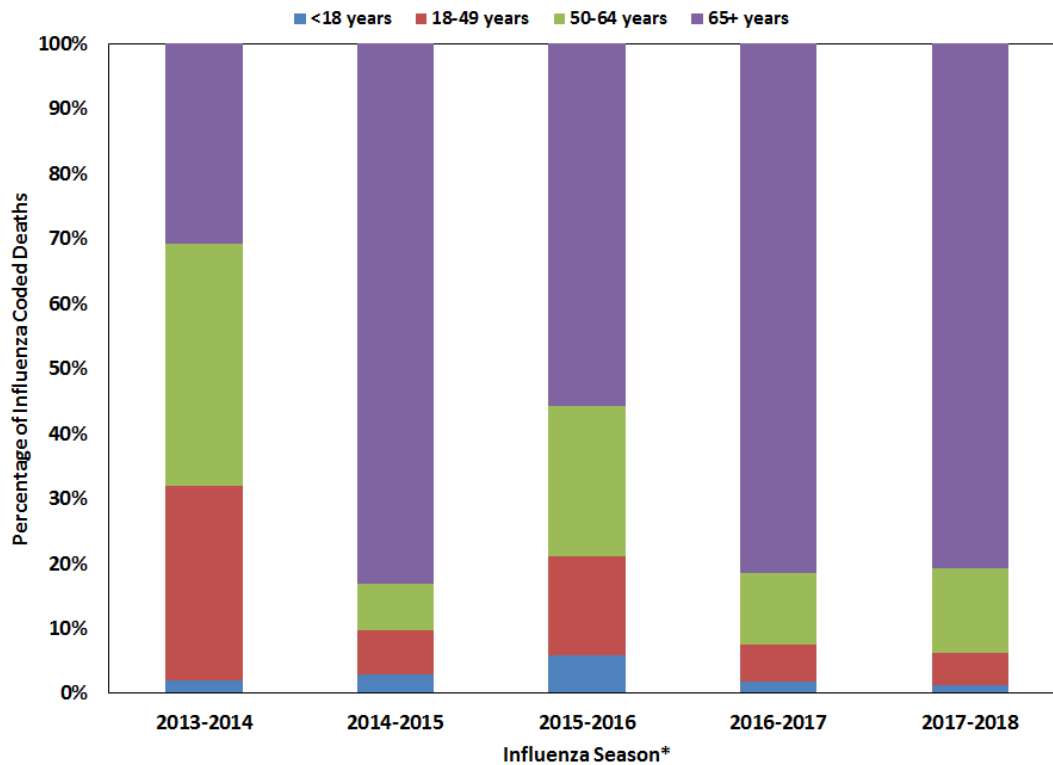
* 2013–2014 influenza season: September 29, 2013–September 27, 2014; influenza A (H1N1)pdm09 predominant season
2014–2015 influenza season: September 28, 2014–October 3, 2015; influenza A (H3N2) predominant season
2015–2016 influenza season: October 4, 2015–October 1, 2016; mixed influenza A and influenza B season
2016–2017 influenza season: October 2, 2016–September 30, 2017; influenza A (H3N2) predominant season
2017–2018 influenza season: October 1, 2017–September 29, 2018; influenza A (H3N2) predominant season
Data not available prior to January 1, 2014, so any influenza-coded deaths that occurred during September 29–December 31, 2013 are not included

D. Outbreaks of Respiratory Illness, Including Influenza

Outbreaks are required to be reported to the local health authority under Title 17, CCR 2500; however, outbreaks occurring in residential care facilities are more likely to be identified and reported to CDPH than other respiratory outbreaks. In general, respiratory, non-tuberculosis outbreaks are defined as a sudden increase of acute respiratory illnesses over the normal background rate.

From October 1, 2017 to May 19, 2018 local health departments reported a total of 721 confirmed non-tuberculosis respiratory outbreaks to the CDPH. The outbreaks were reported from 44 local health jurisdictions throughout the state. There was a substantial increase in the number of outbreaks reported during the 2017–2018 season compared to the 2016–2017 influenza season (n=335). Of the 721 confirmed respiratory outbreaks, influenza was the most commonly identified pathogen (659; 91.4%, including one outbreak where both influenza and coronavirus were identified). Thirty-five (4.9%) confirmed respiratory outbreaks had no identified etiology. The remaining 27 (3.7%) outbreaks identified RSV (9), rhinovirus (5),
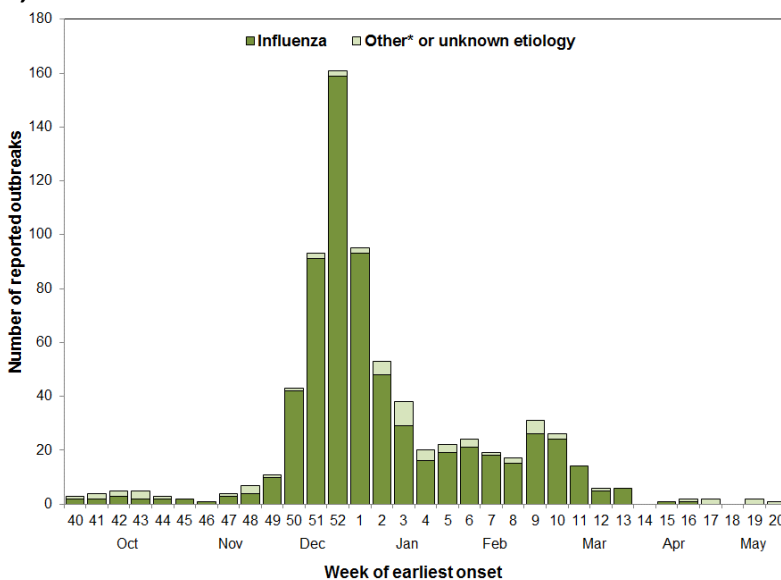
pertussis (4), coronavirus (2), human metapneumovirus (2), parainfluenza virus (2), streptococcal infection (2), and *Mycoplasma pneumoniae* (1).

The first influenza-associated outbreak identified during the 2017–2018 influenza season occurred in early October 2017 (Figure 13). Influenza outbreaks continued to occur through April, with peak activity occurring in late December 2017. Three confirmed influenza outbreaks were reported to the CDPH with initial case onset during the weeks ending May 26, 2018 through September 29, 2018.

Of the 659 influenza-associated outbreaks, 432 (65.6%) were associated with influenza A and 115 (17.5%) were associated with influenza B. An additional 60 (9.1%) outbreaks were associated with both influenza A and influenza B, and 52 (7.9%) were associated with influenza, but the influenza type was not known. Of the 432 outbreaks where influenza A viruses were identified, 113 had subtyping information available; 108 (95.6%) were A (H3N2), and five (4.4%) were A (H1N1)pdm09. Of the 115 outbreaks where influenza B viruses were identified, 10 had lineage typing performed; nine (90.9%) were B/Yamagata lineage and one (10.0%) was B/Victoria lineage. Most influenza A (319; 73.8%) and influenza B (105; 91.3%) specimens were not subtyped or lineage typed.

Of the 659 influenza-associated outbreaks, 363 (55.1%) occurred in residential healthcare facilities, such as skilled nursing facilities, and 216 (32.8%) occurred in assisted or independent living facilities (congregate residential facilities not providing routine healthcare). Local health departments also reported influenza outbreaks in schools (30; 4.6%), correctional facilities (14; 2.1%), acute care facilities (13; 2.0%), and other congregate settings (12; 1.8%). Eleven (1.7%) had unknown facility type.

Figure 13. Reported respiratory outbreaks by week of earliest onset, October 1, 2017–May 19, 2018

* Other etiologies identified by laboratory confirmation included RSV (9), rhinovirus (5), pertussis (4), coronavirus (2), human metapneumovirus (2), parainfluenza virus (2), streptococcal infection (2), and *Mycoplasma pneumoniae* (1). Additionally, there was one influenza outbreak that also identified coronavirus.

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Appendix. Number of influenza-associated fatal cases in persons <65 years of age reported to the California Department of Public Health, by local health jurisdiction, 2013–2014 influenza season through 2017–2018 influenza season

Jurisdiction	2013–2014* Season	2014–2015* Season	2015–2016* Season	2016–2017* Season	2017–2018* Season
CALIFORNIA	419	83	162	119	336
Alameda†	12	2	9	7	14
Berkeley City	0	0	0	0	0
Alpine	0	0	0	0	0
Amador	0	0	0	1	0
Butte	3	0	0	0	1
Calaveras	2	0	0	1	1
Colusa	0	0	0	0	1
Contra Costa	9	1	3	4	10
Del Norte	0	0	0	0	0
El Dorado	3	0	0	1	1
Fresno	22	4	5	2	7
Glenn	1	0	0	0	0
Humboldt	1	1	1	0	1
Imperial	2	0	0	0	1
Inyo	0	0	0	0	0
Kern	11	0	1	2	2
Kings	7	0	1	1	3
Lake	1	0	0	1	2
Lassen	1	0	0	0	1
Los Angeles†	76	16	42	19	66
Long Beach City	8	1	1	0	3
Pasadena City	0	0	0	0	1
Madera	3	1	1	0	1
Marin	2	0	0	0	1
Mariposa	0	0	0	0	0
Mendocino	4	0	0	1	2
Merced	5	0	0	0	0
Modoc	0	0	0	0	0
Mono	0	0	0	0	0
Monterey	7	2	1	4	7
Napa	0	1	0	3	0
Nevada	1	0	0	0	0
Orange	22	11	14	6	24
Placer	1	1	1	2	3
Plumas	0	0	0	0	0
Riverside	24	3	9	4	20
Sacramento	29	4	10	12	20
San Benito	0	0	0	0	0
San Bernardino	32	4	6	2	14
San Diego	44	9	31	14	40
San Francisco	4	1	0	2	4
San Joaquin	8	3	2	7	10
San Luis Obispo	1	0	0	1	1
San Mateo	6	5	2	0	4
Santa Barbara	3	2	4	1	3
Santa Clara	20	2	6	2	12
Santa Cruz	5	0	0	2	3
Shasta	3	1	0	2	4
Sierra	0	0	0	0	0
Siskiyou	2	0	0	0	0
Solano	3	2	2	5	9
Sonoma	7	1	5	0	6
Stanislaus	13	2	1	3	10
Sutter	1	0	0	0	1
Tehama	0	0	0	0	0
Trinity	0	1	0	0	0
Tulare	5	1	1	1	4
Tuolumne	1	0	0	0	0
Ventura	3	1	3	2	12
Yolo	1	0	0	4	4
Yuba	0	0	0	0	2

* 2013–2014: September 29, 2013–September 27, 2014; 2014–2015: September 28, 2014–October 3, 2015; 2015–2016: October 4, 2015–October 2, 2016; 2016–2017: October 3, 2016–September 30, 2017; 2017–2018: October 1, 2017–September 29, 2018
† Does not include city counts