INFLUENZA IN RHODE ISLAND

RHODE ISLAND DEPARTMENT OF HEALTH

2016-2017 EPIDEMIOLOGY AND SURVEILLANCE REPORT

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SUMMARY OF SEASON

This report provides a surveillance summary of seasonal influenza in Rhode Island for the 2016-2017 influenza season (October 2, 2016-May 20, 2017) and compares the 2016-2017 influenza season with the 2015-2016 influenza season (October 4, 2015-May 21, 2016). The Rhode Island Department of Health (RIDOH) Center for Acute Infectious Disease Epidemiology (CAIDE) maintains several influenza surveillance systems that together provide a comprehensive picture of influenza in the state of Rhode Island. These surveillance systems are designed to monitor influenza activity intensity levels and geographic spread of influenza-like illness (ILI); assess the severity of influenza infections within the community as measured by hospitalizations and deaths; characterize circulating influenza strains; and detect novel influenza viruses. Data from each source will be presented and described in this report.

For the 2016-2017 influenza season, the epidemic curves from all surveillance sources revealed a moderate influenza season which peaked during three weeks in February: Morbidity and Mortality Weekly Report (MMWR) Weeks 6-8 (February 5 -25, 2017). The level of influenza-like illness at that peak was 4.3% of all provider visits, a three-fold increase over the regional baseline of 1.4% ILI. The three-week duration of the peak of the 2016-2017 influenza season was unusual, as most influenza seasons have only one week of peak activity. The overall level of influenza activity was higher in 2016-2017 than in the 2015-2016 influenza season.

Influenza A viruses predominated in the 2016-2017 season. Of the Influenza A specimens that were subtyped, Influenza A (H3N2) was the most prevalent. This strain was predominant across all influenza surveillance systems, both in Rhode Island and nationally. Influenza A (H3N2) strains of influenza are known to be associated with severe illness, mortality, and increased hospitalization, particularly among older adults and those with compromised immune systems. The 2016-2017 influenza season was moderate, with overall high levels of outpatient illness and influenza-associated hospitalization, especially for adults age 65 or older. The severity of the season, as measured by inpatient hospitalizations and mortality, was similar to other seasons where Influenza A (H3N2) viruses predominated, such as the 2014-2015 and 2012-2013 influenza seasons[1,2].

Although Influenza A viruses were predominant in the overall influenza season, Influenza B viruses became more common in the latter half of the influenza season. Influenza B viruses comprised more than half of positive influenza specimens in MMWR Weeks 11-20 (March 12-May 20, 2017). This increase in Influenza B viruses caused a secondary peak in ILI and influenza in MMWR Weeks 12-14 (March 19-April 8, 2017), even as Influenza A viruses declined. Of the Influenza B viruses with lineage testing conducted, the majority were Influenza B Yamagata, both in Rhode Island and in the United States as a whole[1].

The 2016-2017 seasonal influenza vaccine was reasonably well-matched to the influenza viruses circulating throughout the season[1,3]. The estimated vaccine effectiveness in 2016-2017 was 42%, which is slightly lower than the 2015-2016 seasonal influenza vaccine effectiveness of 47%. Vaccination with the 2016-2017 seasonal influenza vaccine reduced the risk for outpatient influenza-associated medical visits by nearly half. The 2016-2017 seasonal influenza vaccine was significantly more effective against the circulating Influenza A (H3N2) viruses than the 2014-2015 seasonal influenza vaccine was against the Influenza A (H3N2) circulating in that season. During the 2014-2015 season, the most recent Influenza A (H3N2)-predominant season, the seasonal influenza vaccine had a vaccine effectiveness of only 19%[4]. This low vaccine effectiveness occurred because the primary circulating Influenza A (H3N2) virus had genetically drifted from the Influenza A (H3N2) virus in the 2014-2015 seasonal influenza vaccine, leading to reduced vaccine effectiveness[5]. Fortunately, the 2016-2017 seasonal influenza vaccine had improved protection against H3N2 and other circulating influenza viruses, and genetic drift did not occur.

In Rhode Island, 5,045 specimens tested positive for influenza at Rhode Island hospitals, and 1,216 individuals who tested positive for influenza were admitted to the hospital. At the RIDOH State Health Laboratories (RSHL), 214 specimens tested positive for influenza and were subtyped or lineage tested. RIDOH responded to and monitored 115 respiratory outbreaks in congregate living settings, such as long-term care facilities, assisted-living facilities, hospitals, and universities. There were 33 influenza-associated deaths reported to RIDOH during the 2016-2017 influenza season.

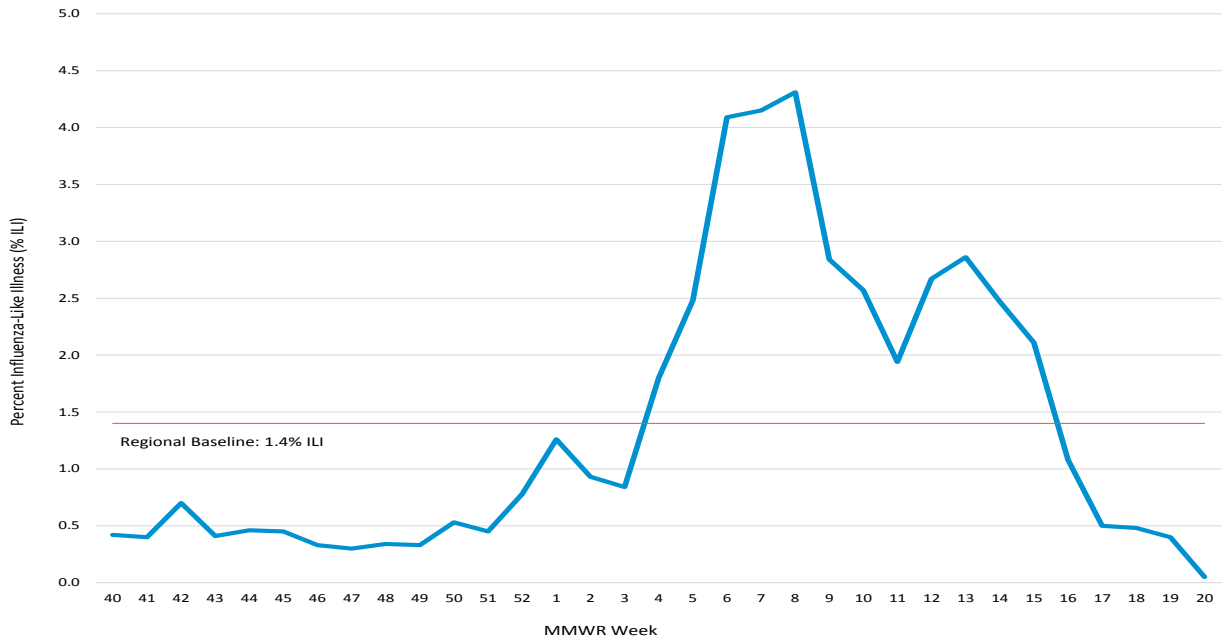
Rhode Island's robust, multi-source influenza surveillance system provided a well-rounded picture of a moderate influenza season. The subsequent sections of this report contain detailed information on each portion of that surveillance system and the findings for the 2016-2017 influenza season.

ILI NETWORK (ILINet): SENTINEL PRACTICES IN THE COMMUNITY

RIDOH participates in an outpatient illness surveillance program known as the US Outpatient Influenza-like Illness Surveillance Network (ILINet)[6]. This program is a collaborative effort among the Centers for Disease Control and Prevention (CDC), state health departments, and sentinel outpatient healthcare providers recruited by each state. In Rhode Island, 17 community-based healthcare practices geographically dispersed throughout Rhode Island serve as ILINet sentinel providers. In the 2016-2017 influenza season, Rhode Island's ILINet sentinel providers consisted of six family practices, four student health centers, four pediatric practices, two internal medicine practices, and one urgent care center (Appendix B).

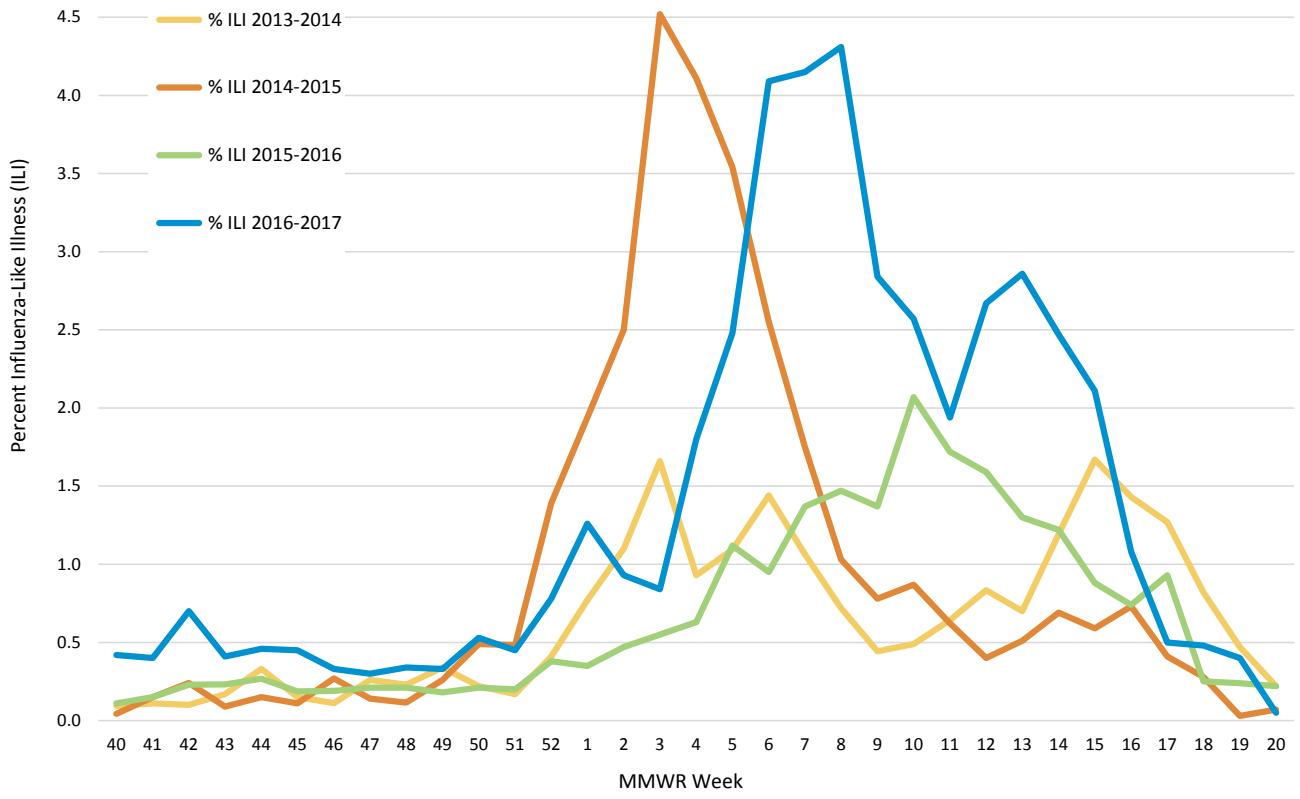
Each week of the year, ILINet providers report data to RIDOH and CDC on the total number of patients seen in the practice for any reason and the number of those patients presenting with influenza-like illness, or ILI. Influenza-like illness is defined as a fever (≥ 100° F or 37.8°C) and cough and/or sore throat in the absence of a known cause other than influenza. ILI is assessed solely on symptoms and is independent of laboratory testing for influenza or other infectious diseases. Data are aggregated by age group (0-4 years, 5-24 years, 25-49 years, 50-64 years, and 65 years and older). RIDOH analyzes ILINet data weekly to determine the geographic spread of ILI throughout the state and the level of ILI in each county. Sentinel surveillance through ILI Net is an essential component of influenza surveillance in Rhode Island.

FIGURE 1: INFLUENZA-LIKE ILLNESS AS A PERCENTAGE OF ALL PATIENT VISITS TO ILINET SENTINEL PROVIDERS, 2016-2017 INFLUENZA SEASON, RHODE ISLAND



In the 2016-2017 influenza season, which occurred between October 2, 2016, and May 20, 2017, levels of influenza-like illness remained below the regional baseline of 1.4% until MMWR Week 3 (January 15-21, 2017), then climbed quickly in the next three weeks. The 2016-2017 influenza season had a three-week peak of ILI, in MMWR Weeks 6-8 (February 5-25, 2017). This peak was unusual, as most seasons only have one peak week of ILI. The highest ILI during the peak weeks occurred in MMWR Week 8 (February 19-25, 2017) with 4.3% of all visits to sentinel healthcare providers related to ILI. ILI declined in the next three weeks, then increased again for a second smaller peak in MMWR Week 13 (March 26-April 1, 2017), with 2.9% of all visits to sentinel healthcare providers related to ILI. The reasons for this secondary peak will be discussed later in this report.

FIGURE 2: PERCENTAGE OF VISITS FOR ILI REPORTED BY ILINET, 2013-2017 INFLUENZA SEASONS, RHODE ISLAND



The 2016-2017 influenza season had a significantly higher level of ILI activity than the 2015-2016 influenza season. The 2015-2016 influenza season peaked unusually late, in MMWR Week 10 (March 6-12, 2016), with 2.1% of all visits to sentinel providers related to ILI. The 2016-2017 season peak of 4.3% represented a two-fold increase over the 2.1% peak of the 2015-2016 influenza season. The peak of the 2016-2017 influenza season was closest in magnitude to the 2014-2015 influenza season, another Influenza A (H3N2)-predominant season, which peaked in MMWR Week 3 (January 18-24, 2015) at 4.5% ILI.

FIGURE 3: ILI AS A PERCENTAGE OF ALL PATIENT VISITS TO ILINET SENTINEL PROVIDERS, 2016-2017 INFLUENZA SEASON, RHODE ISLAND, NEW ENGLAND, AND THE UNITED STATES

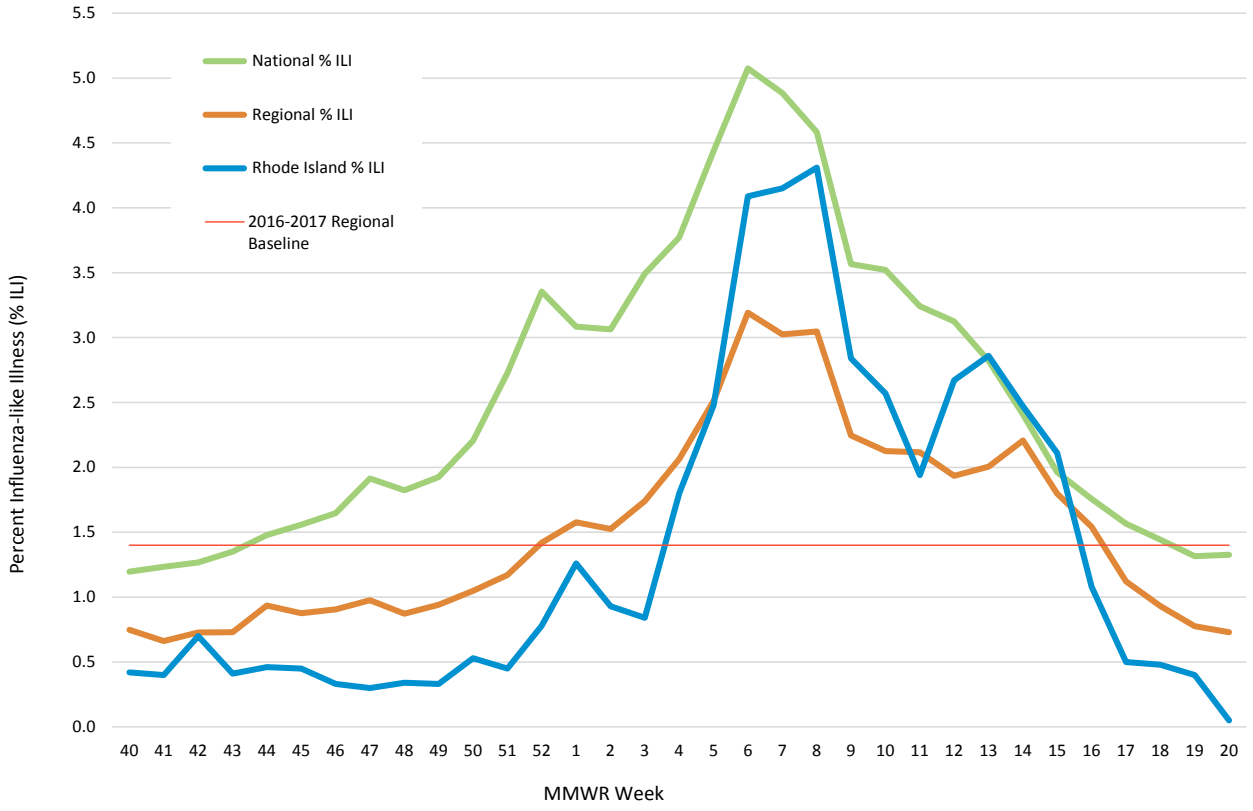


Figure 3 compares the percentage of ILI in Rhode Island to the percentage of ILI in the nation and in Region 1. Region 1 is comprised of the New England states: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. Region 1 ILI activity increased above the regional baseline of 1.4% ILI in MMWR Week 52 (December 25-31, 2016), although Rhode Island ILI activity did not cross above the baseline until three weeks later, in MMWR Week 3 (January 15-21, 2017). ILI activity peaked in Rhode Island, Region 1, and the United States during the same three weeks: MMWR Weeks 6-8 (February 5-25, 2017). Typically, Rhode Island has lower levels of ILI than the rest of Region 1, but during the 2016-2017 influenza season, Rhode Island had higher levels of ILI than Region 1 for nine weeks (MMWR Weeks 6-15, with the exception of MMWR Week 11). Rhode Island also had a more defined secondary peak than both the United States and Region 1, in MMWR weeks 12-13 (March 19-April 1, 2017).

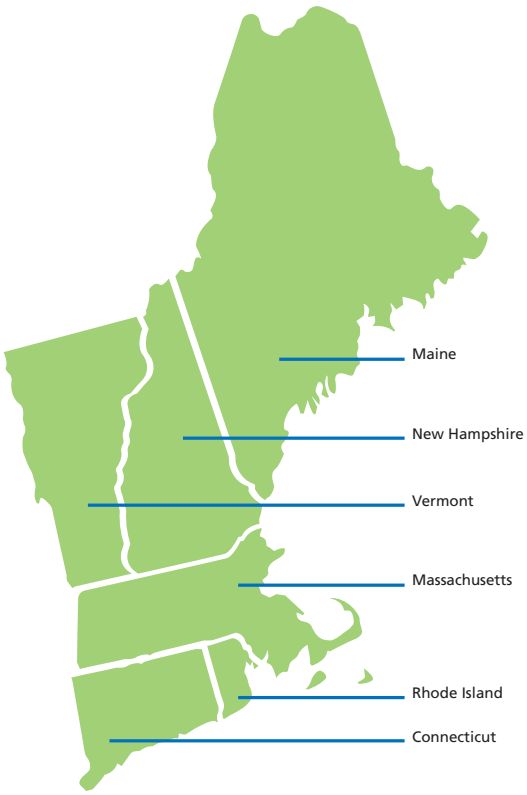
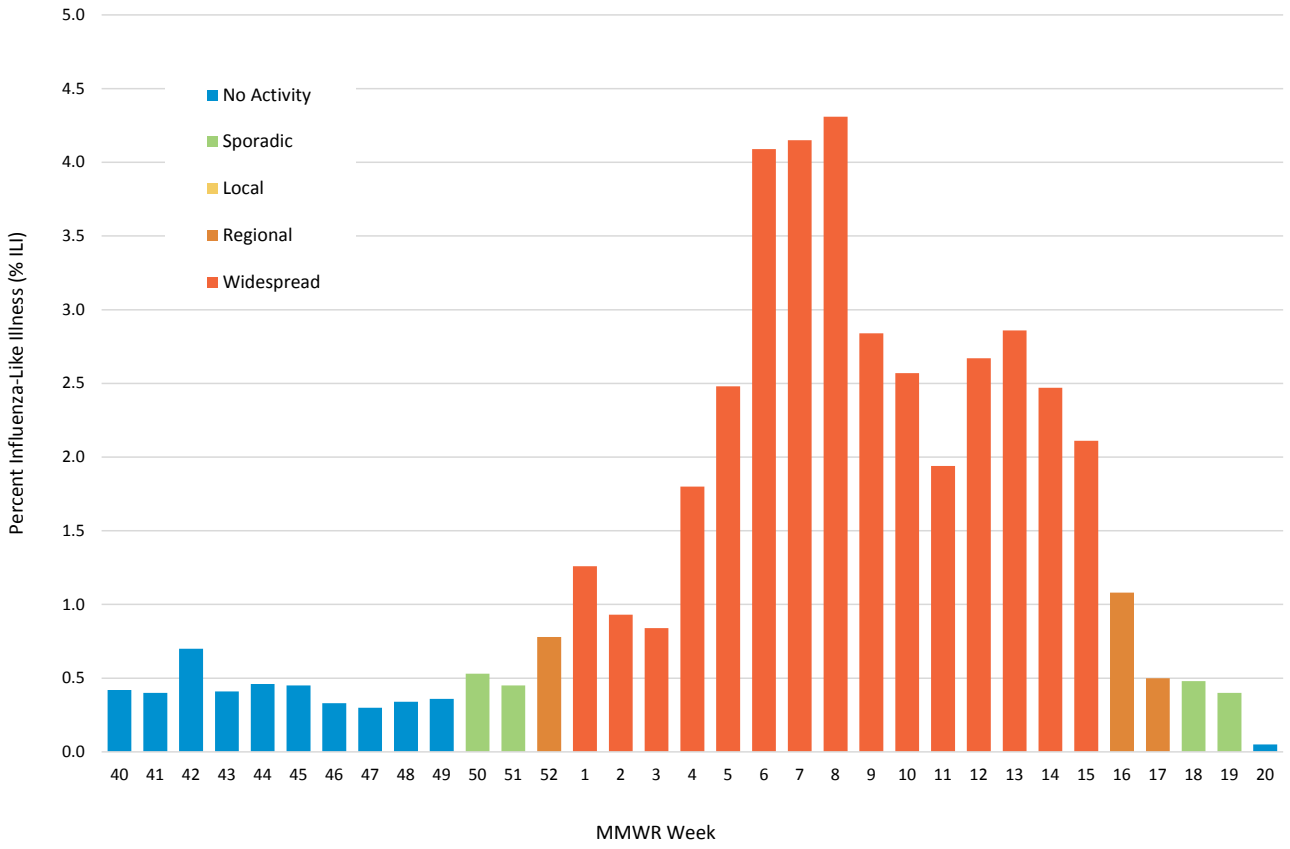


FIGURE 4: ILINET: PERCENTAGE OF SENTINEL VISITS FOR ILI AND GEOGRAPHIC SPREAD OF INFLUENZA ACTIVITY, RHODE ISLAND 2016-2017 INFLUENZA SEASON



Geographic spread is a metric that all states report weekly to CDC[6]. This metric describes the locational range of ILI within a state but does not measure the severity of the state's influenza activity. The levels of geographic spread, in order from least to greatest activity, are No Activity, Sporadic, Local, Regional, and Widespread. The Influenza Surveillance Coordinator and State Epidemiologist at RIDOH determine the geographic spread of ILI within Rhode Island using CDC's algorithm (Appendix C). Figure 4 shows the percentage of ILI and the geographic spread of ILI in Rhode Island, by week. ILI became more geographically dispersed as ILI increased in Rhode Island. Rhode Island had widespread influenza activity for 15 weeks in the 2016-2017 influenza season, from MMWR Week 1 through MMWR Week 15 (January 1–April 15, 2017). This represents a three-fold increase in the duration of widespread activity over the 2015-2016 influenza season, which had five weeks of widespread activity.

FIGURE 5: NUMBER OF VISITS FOR ILI REPORTED BY ILINET SENTINEL PROVIDERS IN RHODE ISLAND BY AGE-SPECIFIC GROUP, 2016-2017 SEASON

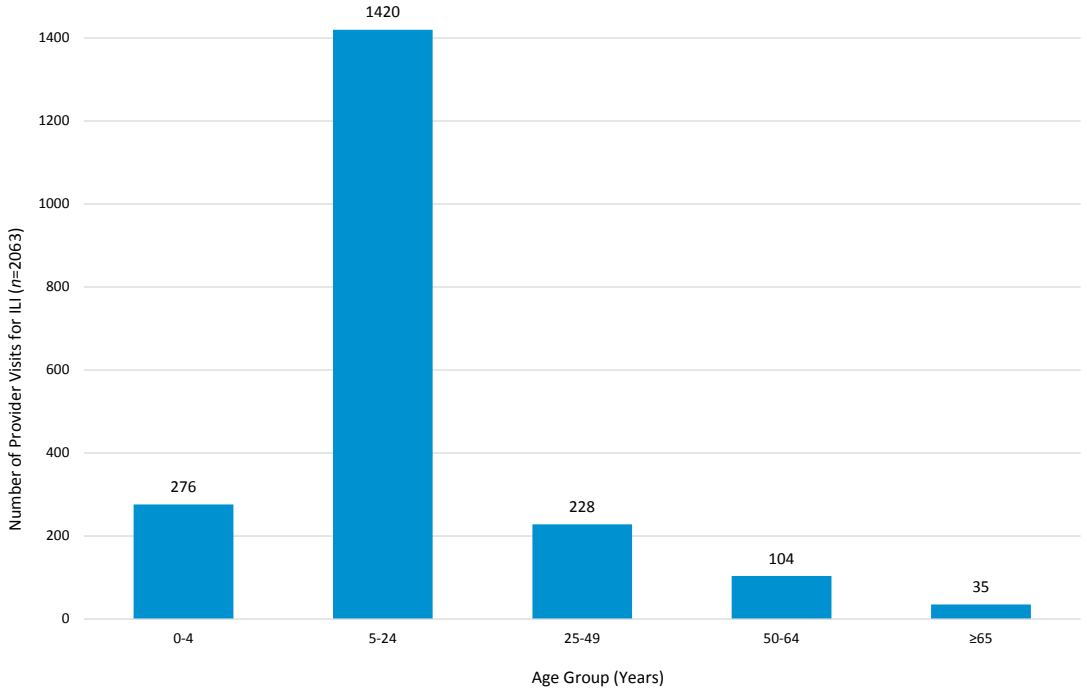


Figure 5 shows the age distribution of individuals with ILI who visited ILINet providers during the 2016-2017 influenza season. Throughout the 2016-2017 influenza season, there were 2,063 visits for ILI to sentinel ILINet providers in Rhode Island. These providers reported the highest number of visits for ILI among children and young adults ages 5-24, with 1,420 visits throughout the 2016-2017 influenza season (69% of all patients with ILI). Adults 65 and older had the lowest reported number of ILI visits with 35 visits during the season (just 2% of all ILI visits).

The age breakdown of sentinel-reported ILI can be misleading. From this graph, it might appear that Rhode Island had low levels of ILI in older adults; however, this is not the case. ILINet data measure visits to healthcare providers in the community, but do not measure emergency department visits or inpatient hospitalizations. Nationally, adults age 65 and older have the highest rates of influenza-related hospitalization among all age groups and often have severe outcomes from influenza[7]. High rates of hospitalization among older adults occur in Rhode Island as well (See Figure 11). While Figure 5 accurately portrays high levels of ILI among individuals ages 5-24, it does not present the full picture of age and influenza or ILI in our state.

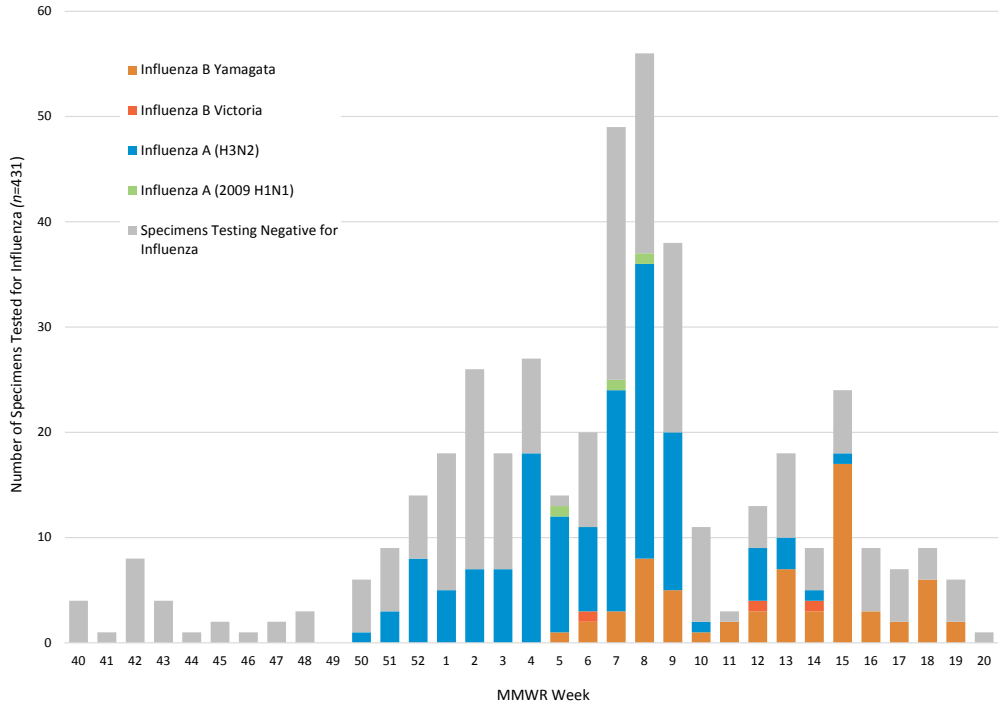
SUMMARY OF ILINET DATA, 2016-2017

The 2016-2017 influenza season showed high levels of ILI peaking during three weeks in February: MMWR Weeks 6-8 (February 5-25, 2017). The peak of the percentage of ILI was higher than the 2015-2016 influenza season, but not quite as high as the 2014-2015 influenza season. The 2016-2017 influenza season had a secondary peak during MMWR Weeks 12-13 (March 19-April 1, 2017). Rhode Island had a long influenza season, with 15 weeks of widespread influenza activity. While ILINet data do not show severity of influenza (hospitalizations and deaths), or laboratory testing for influenza, they do show that there was sustained transmission of ILI throughout the state for nearly the entire influenza season.

RIDOH STATE HEALTH LABORATORIES DATA

The State Health Laboratories (RSHL) accepts nasopharyngeal swab specimens from specific sources to monitor circulating strains and subtypes of influenza. Each ILINet sentinel provider is required to send nine specimens to RSHL (three early in the season, three mid-season, and three late in the season). Respiratory outbreaks in congregate living facilities are confirmed via specimen submission to RSHL. In addition, hospitals occasionally send specimens for confirmatory influenza testing, particularly for non-subtypable strains. RSHL uses molecular testing for influenza, which subtypes or lineage tests the virus. This method of testing provides important information on the strains of influenza circulating in Rhode Island and contributes to CDC's national and regional data on influenza strains. RSHL also submits samples to CDC to monitor antiviral susceptibility of circulating strains of influenza and to aid in the identification of novel viruses.

FIGURE 6: POSITIVE INFLUENZA TESTS BY STRAIN AND MMWR WEEK, RHODE ISLAND STATE HEALTH LABORATORY, 2016-2017



In the 2016-2017 influenza season, the RSHL tested 431 specimens for influenza. Of these specimens, 214 tested positive. Of positive specimens, 68% were Influenza A, and 32% were Influenza B. All Influenza A-positive specimens were subtyped, and all Influenza B-positive specimens were lineage tested. Of the Influenza A specimens, 97.9% were Influenza A (H3N2), consistent with national predominance of Influenza A (H3N2) during the 2016-2017 influenza season. Nationally, 97.2% of subtyped Influenza A viruses were Influenza A (H3N2)[8]. In Rhode Island, the predominant lineage of Influenza B viruses was Influenza B Yamagata, making up 30% of all positive influenza tests, and 96% of Influenza B specimens. Nationally, Influenza B Yamagata comprised 71.2% of lineage-tested Influenza B specimens. Although RSHL tests specimens all year long, the first influenza-positive specimens appeared in Rhode Island during MMWR Week 50 (December 11-17, 2016), and positive tests began to increase in MMWR Week 52 (December 25-31, 2016). This increase occurred much earlier than in the 2015-2016 influenza season, when positive influenza test results did not increase until MMWR Week 5 (January 31-February 6, 2016). The number of positive influenza tests peaked in MMWR Week 8 (February 19-25, 2017) which coincided with the three peak weeks of Rhode Island's influenza season. As the season progressed, fewer specimens tested positive for Influenza A viruses, and more tested positive for Influenza B viruses. This shift is consistent with Rhode Island hospital influenza tests (discussed below in this report) and national influenza laboratory trends.

HOSPITAL DATA

Each week, Rhode Island's 11 acute-care hospitals reported patient-level data on all positive influenza laboratory tests to RIDOH. These data include influenza tests conducted in both emergency departments and inpatient units. Hospitals also reported the total number of influenza tests conducted that week, which allows RIDOH to calculate the percent positivity of influenza tests. The following graphs compare hospital data from the 2016-2017 influenza season with hospital data from the 2015-2016 influenza season.

FIGURE 7: ALL POSITIVE INFLUENZA TESTS BY STRAIN AND MMWR WEEK, RHODE ISLAND HOSPITALS, 2016-2017 INFLUENZA SEASON

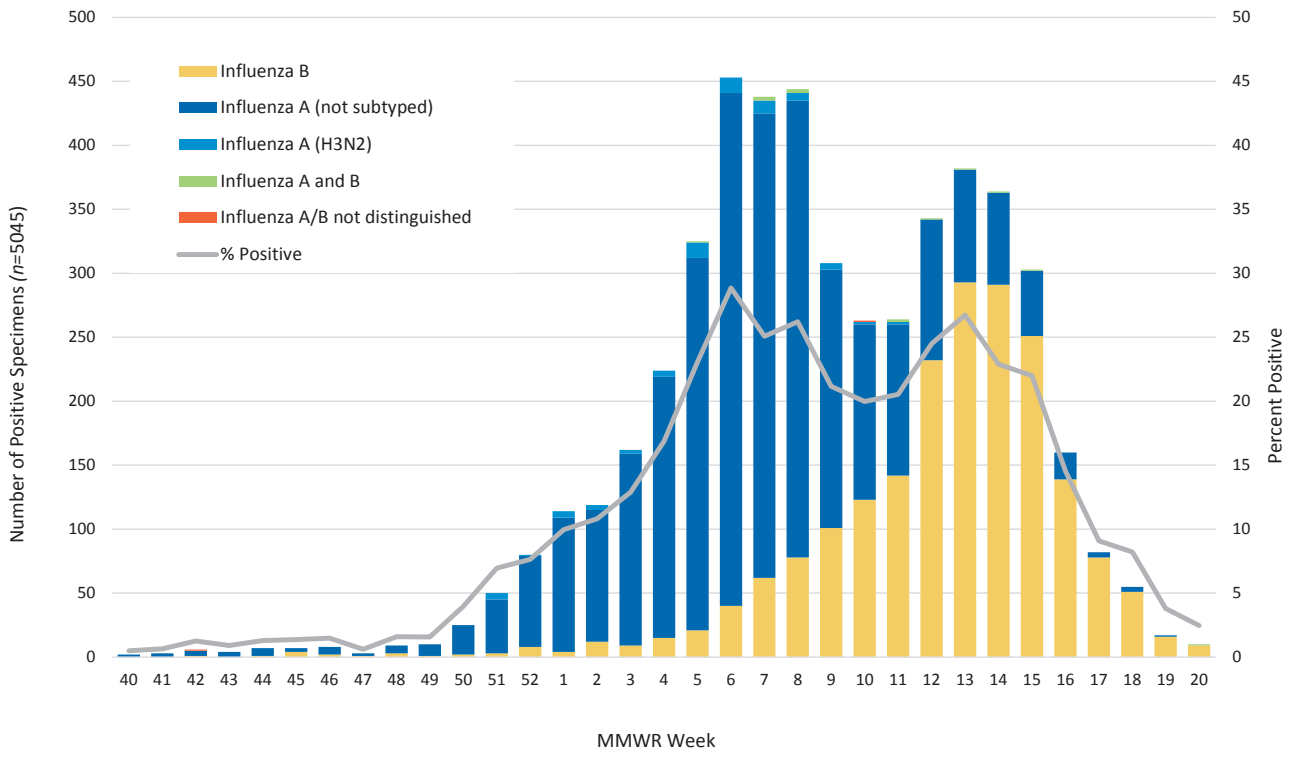
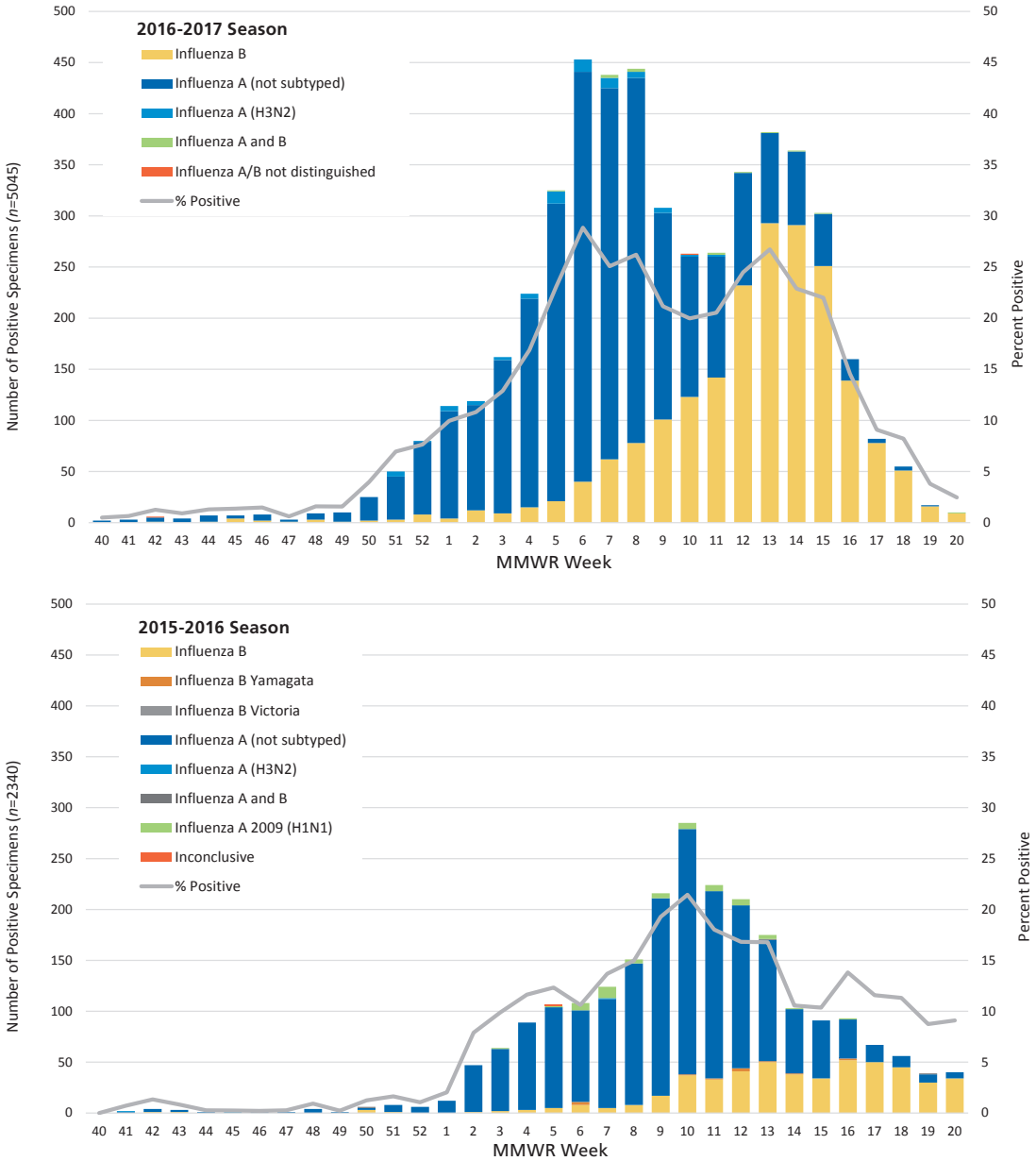


Figure 7 shows all positive influenza tests in Rhode Island hospitals during the 2016-2017 influenza season, displayed by influenza virus type and MMWR week. In the 2016-2017 influenza season, 5,045 specimens tested positive for influenza in Rhode Island hospitals. The number of positive tests peaked between MMWR Weeks 6-8 (February 5-25, 2017), at 438-453 influenza-positive tests per week. During those three weeks, between 25.1% and 28.9% of all influenza specimens at Rhode Island hospitals tested positive for influenza. This first three-week peak was caused by Influenza A viruses, as Influenza A viruses were predominant during the first half of the influenza season. As Influenza A virus infections declined following the peak weeks, Influenza B virus infections increased, causing a clear secondary peak of influenza in MMWR Weeks 12-14 (March 19-April 8, 2017). Influenza B viruses were predominant in Rhode Island hospitals in MMWR Weeks 11-20 (March 12-May 20, 2017), as Influenza A continued to decline. Influenza B viruses typically appear midway through an influenza season and increase later in the season, although they do not always cause a secondary peak as they did in the 2016-2017 influenza season. Both the primary and secondary peaks of hospital influenza tests occurred in the same weeks as the peaks of ILI reported by sentinel providers.

FIGURE 8: ALL POSITIVE INFLUENZA TESTS BY STRAIN AND MMWR WEEK, RHODE ISLAND HOSPITALS, COMPARISON OF 2016-2017 INFLUENZA SEASON WITH 2015-2016 INFLUENZA SEASON



During the 2016-2017 influenza season, there was a greater than two-fold increase in the number of positive influenza tests during the 2015-2016 influenza season. While the 2016-2017 influenza season peaked for three weeks, in MMWR Weeks 6-8 (February 5-25, 2017), with between 438-453 influenza-positive tests per week, the 2015-2016 influenza season peaked for one week during MMWR Week 10 (March 6-12, 2016), with 285 positive influenza tests. In both seasons, Influenza A was predominant and Influenza B became more prevalent in the latter half of the season. The 2016-2017 influenza season had a secondary peak caused by Influenza B viruses from MMWR Weeks 12-14 (March 19-April 8, 2017). This second, smaller peak had more positive influenza tests than the peak week of the 2015-2016 influenza season (382 positives in MMWR Week 13, 2017 versus 285 tests in MMWR Week 10, 2016). The 2015-2016 season had Influenza B virus activity in the second half of the influenza season, but did not have a clear secondary peak. Compared to the 2016-2017 influenza season, the 2015-2016 influenza season was mild, with one peak and a lower overall number of positive influenza tests.

TABLE 1: ALL POSITIVE INFLUENZA TESTS BY STRAIN, RHODE ISLAND HOSPITALS, COMPARISON OF 2016-2017 INFLUENZA SEASON WITH THE 2015-2016 INFLUENZA SEASON

	All Positive Influenza Tests			
	2016 - 2017		2015- 2016	
Strain	**N**	**%**	**N**	**%**
Influenza A (not subtyped)	2,963	59%	1,767	76%
Influenza B (not subtyped)	1,993	40%	499	21%
Influenza A (H3N2)	72	1%	3	0%
Influenza A (H1N1) 2009	0	0%	53	2%
Influenza A and B	14	0%	3	0%
Influenza B Yamagata	0	0%	11	0%
Influenza B Victoria	0	0%	1	0%
Influenza A/B not distinguished	2	0%	2	0%
Inconclusive	1	0%	1	0%
Total	**5,045**		**2,340**	

In both the 2016-2017 and the 2015-2016 influenza seasons, Influenza A (not subtyped) comprised the largest percentage of positive tests (75.5% in 2015-2016 and 75.2% in 2014-2015). Influenza B comprised the second-highest percentage of tests in both seasons (21.3% in 2015-2016 and 15.4% in 2014-2015). Of subtyped Influenza A specimens, Influenza A (H1N1) 2009 was the predominant strain in 2015-2016, while Influenza A (H3N2) was the predominant strain in the 2016-2017 flu season. Overall, fewer specimens were subtyped in hospital laboratories during the 2016-2017 flu season.

INFLUENZA TEST TYPES IN HOSPITALS

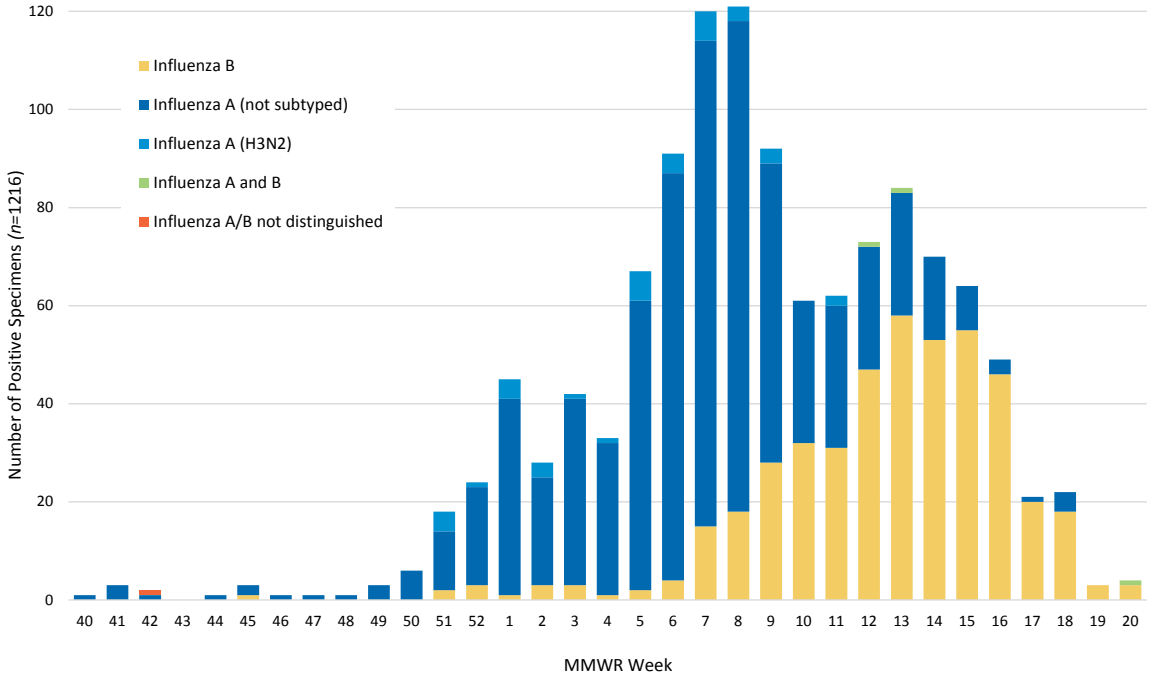
Hospitals use two types of tests for influenza: molecular assays and rapid diagnostic tests. In the 2016-2017 influenza season, 61.5% of positive specimens were assessed by rapid influenza diagnostic tests, and 38.5% were tested by molecular assay. Rapid influenza diagnostic tests can determine if an individual is infected with an Influenza A or B virus but cannot further characterize the virus, while molecular assays can determine Influenza A subtype (such as Influenza A (H1N1) 2009) or Influenza B lineage (such as Influenza B Yamagata). In the 2016-2017 season, hospitals that utilized molecular assays did not typically subtype or lineage test their influenza specimens. Although specific viral information is useful for public health, it does not affect clinical decision making or the course of treatment. Therefore, few hospital positive specimens were further characterized in 2016-2017, and most results were reported as Influenza A (not subtyped) or Influenza B (not subtyped).

During the beginning and end of influenza season, rapid diagnostic tests are not as specific as molecular tests and can result in false positives. During the peak of the influenza season, rapid tests are not as sensitive and can result in false negatives. However, due to their speed of providing results and ease of use, they remain an important component of the armamentarium of influenza tests.

INFLUENZA-RELATED HOSPITALIZATIONS

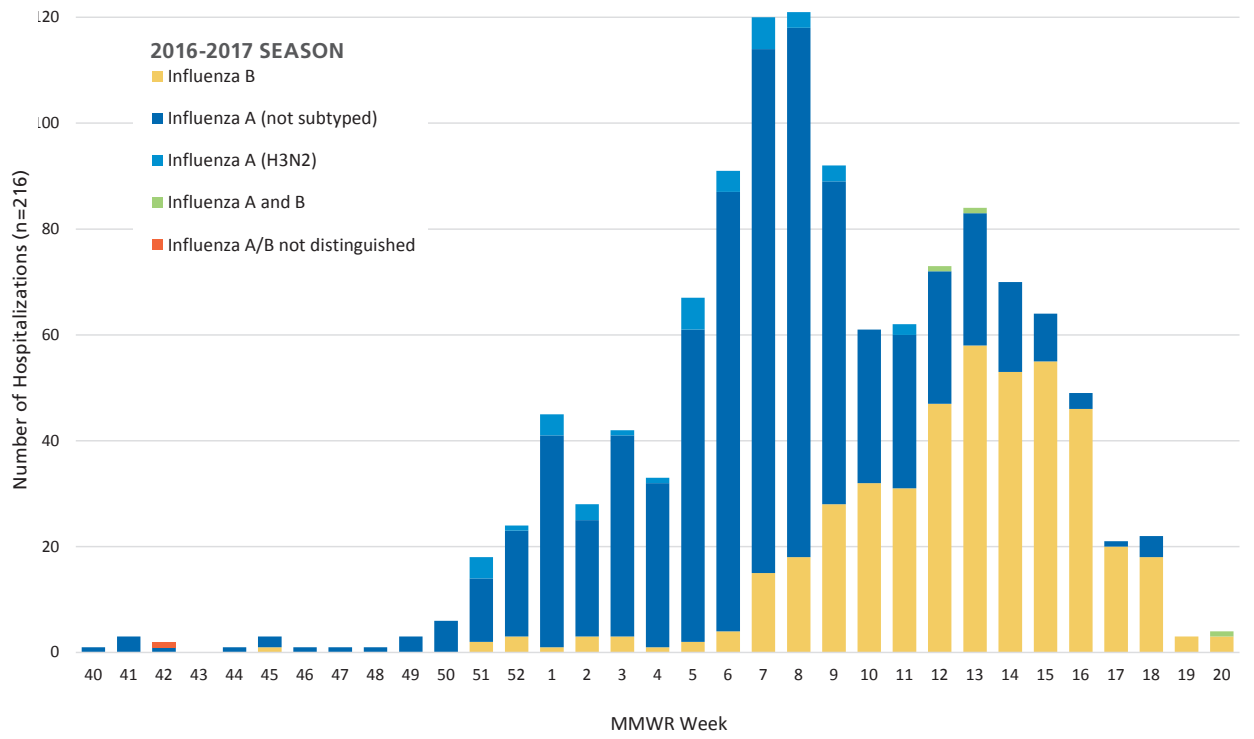
Data on influenza-related hospitalizations are a subset of the data on all positive influenza tests at hospitals described above. This subset consists of individuals who tested positive for influenza and were hospitalized as inpatients.

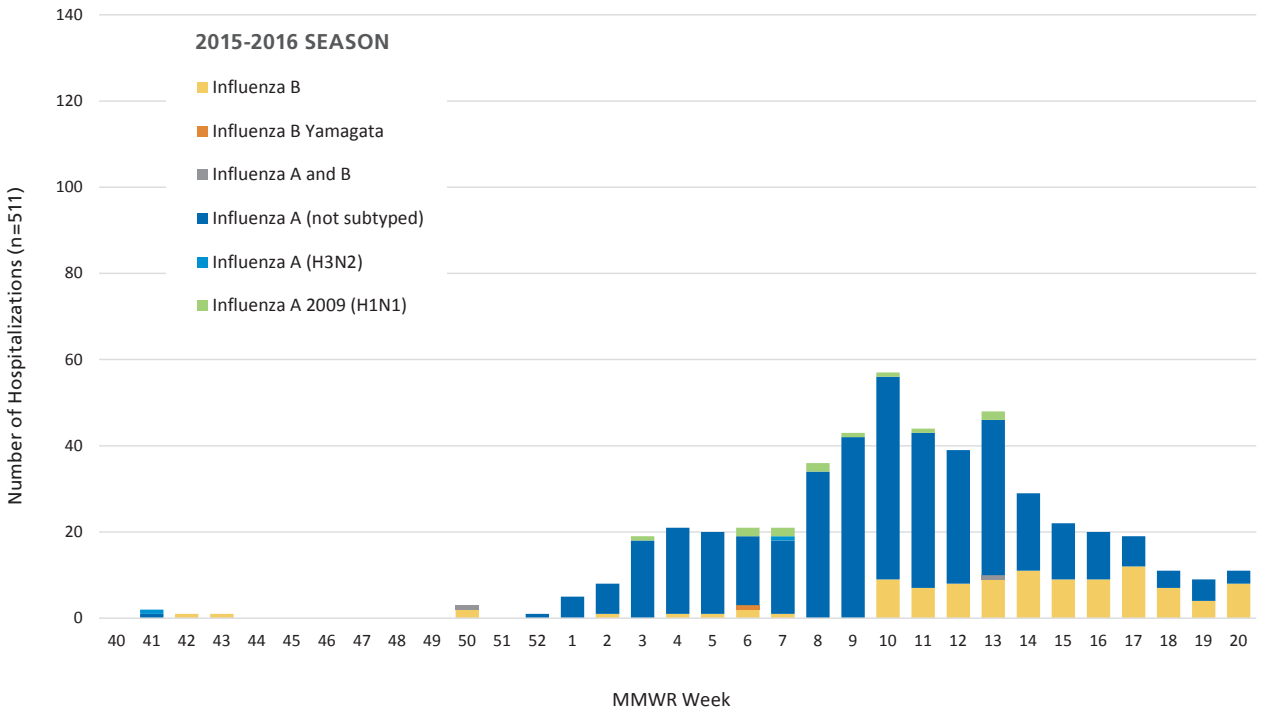
FIGURE 9: INFLUENZA HOSPITALIZATIONS BY STRAIN AND MMWR WEEK, RHODE ISLAND HOSPITALS, 2016-2017 INFLUENZA SEASON



In the 2016-2017 influenza season, 1,216 individuals who tested positive for influenza were hospitalized. The shape of the curve for hospitalizations is similar to the curve of all positive influenza tests (Figure 7), although the first peak in inpatient hospitalizations lasted two weeks (MMWR Weeks 7-8 [February 12-25, 2017]), while the first peak in all positive influenza tests occurred over three weeks, beginning one week earlier (MMWR Weeks 6-8 [February 5-25, 2017]). The secondary peak due to Influenza B viruses is clearly visible in the hospitalized population.

FIGURE 10: INFLUENZA HOSPITALIZATIONS BY STRAIN AND MMWR WEEK, RHODE ISLAND HOSPITALS, COMPARISON OF 2016-2017 AND 2015-2016 INFLUENZA SEASONS





Compared to the 2015-2016 influenza season, the 2016-2017 influenza season had greater numbers of influenza-related hospitalizations. In 2016-2017, 1,216 individuals were hospitalized, a two-fold increase over the 2015-2016 influenza season, when 511 individuals were hospitalized. The peak number of influenza hospitalizations in 2016-2017 was 121 hospitalizations in MMWR Week 8, while the peak number of influenza hospitalizations in 2015-2016 was less than half that number: 57 in MMWR Week 10. In both influenza seasons, Influenza A (not subtyped) was predominant, although Influenza B became more prevalent in the latter half of the season. The higher levels of hospitalization in the 2016-2017 influenza season are consistent with an Influenza A (H3N2)-predominant influenza season. Data in the hospitalization graphs from both years are a subset of the data in Figures 7 and 8.

FIGURE 11: POSITIVE INFLUENZA TESTS BY HOSPITALIZATION STATUS AND AGE, RHODE ISLAND HOSPITALS, 2016-2017 INFLUENZA SEASON

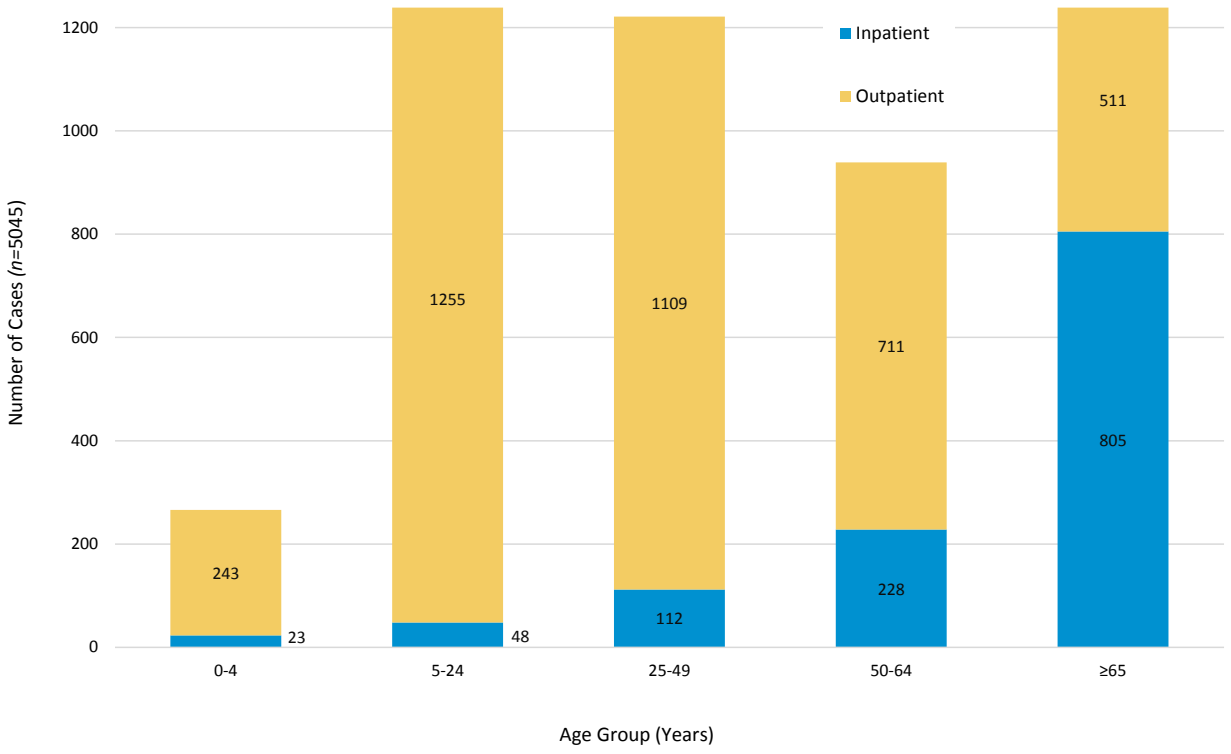
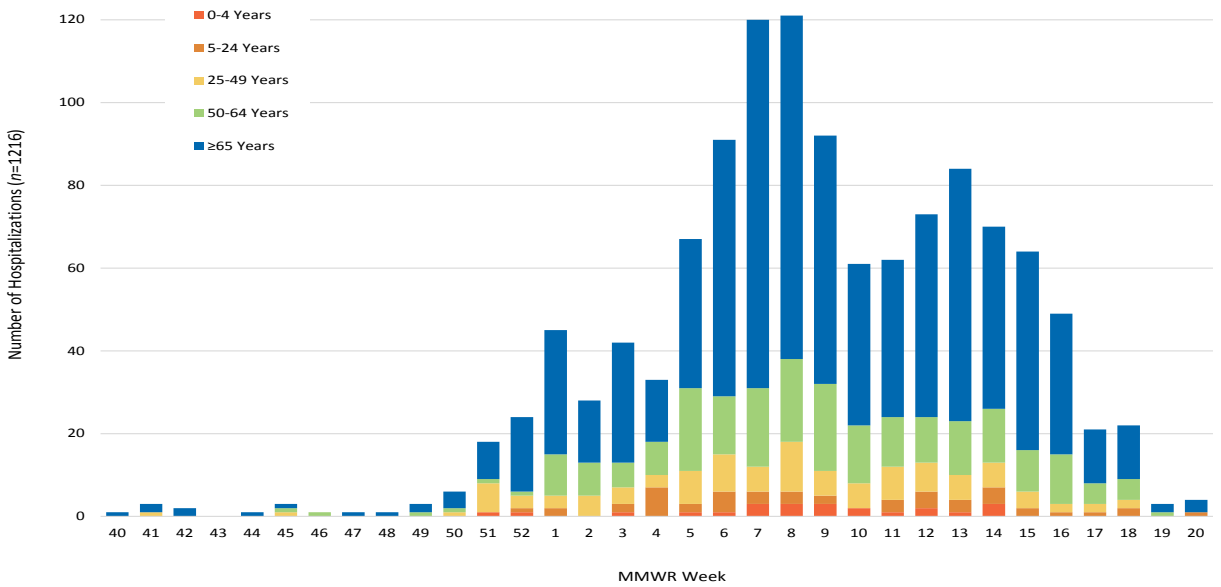


Figure 11 displays an aggregate of all positive hospital influenza tests in the 2016-2017 season by age group and type of hospital visit (inpatient or outpatient). The age groups with the greatest number of positive influenza tests were those ages 5-24 years and those age 65 and older. Although the two age groups are nearly tied for total number of positive influenza tests (1,303 versus 1,316 tests), the greatest number of inpatient hospitalizations occurred in adults age 65 and older. This oldest group had 836 hospitalizations in 2016-2017, a 3.4-fold increase over adults age 50-64, the next-greatest group with 228 hospitalizations. The high number of influenza-associated hospitalizations in older adults is typical, particularly in influenza season where Influenza A (H3N2) viruses predominate. Influenza A (H3N2) strains of influenza are known to be associated with severe illness and increased hospitalization among older adults.

FIGURE 12. INFLUENZA HOSPITALIZATIONS BY AGE AND MMWR WEEK, RHODE ISLAND HOSPITALS, 2016-2017 INFLUENZA SEASON



Within each week of the influenza season, individuals 65 and older represented the majority of hospitalizations. Older adults are hospitalized at much higher rates than individuals of other ages. Figures 11 and 12 provide a contrast to the ILI graph displayed earlier (Figure 5) that showed visits to community healthcare providers, in which older adults had the lowest number of healthcare visits related to ILI. The disparity between these graphs highlights the importance of a multi-part influenza surveillance system. It is essential to examine these two data sets in conjunction to gain a comprehensive understanding of the influenza season. While ILINet is an indicator of the volume of influenza in the state, it does not measure severity of disease. Hospitalization data do not show levels of influenza in the general community, but are an indicator of severity. Figures 11 and 12 reflect the fact that older adults are more vulnerable to severe illness and complications from influenza infection, leading to hospitalization.

RESPIRATORY OUTBREAKS

All influenza and respiratory illness outbreaks in congregate living settings are reportable to RIDOH. For surveillance purposes, a respiratory outbreak is defined as one case of laboratory-confirmed influenza in a congregate living setting, or two cases of ILI. Congregate settings include mainly long-term care facilities and assisted living communities, but may also include hospital units, universities, group homes, adult day programs, and other residential programs. When a facility reports an outbreak, RIDOH provides infection control recommendations and telephones the facility regularly to obtain updated case counts and provide additional guidance. Facilities submit three to five nasopharyngeal specimens to the RSHL for testing, subtyping, and lineage identification. RIDOH also tracks illness attack rates and the percentage of residents in a facility who are vaccinated. A facility experiencing an outbreak is monitored until 10 days have passed following its last new case of influenza or respiratory infection. The outbreak is then officially closed and monitoring discontinued. A single facility may have multiple respiratory outbreaks within one influenza season; each outbreak is counted separately.

FIGURE 13: RESPIRATORY OUTBREAKS IN CONGREGATE LIVING FACILITIES, BY STRAIN AND MMWR WEEK, 2016-2017 INFLUENZA SEASON

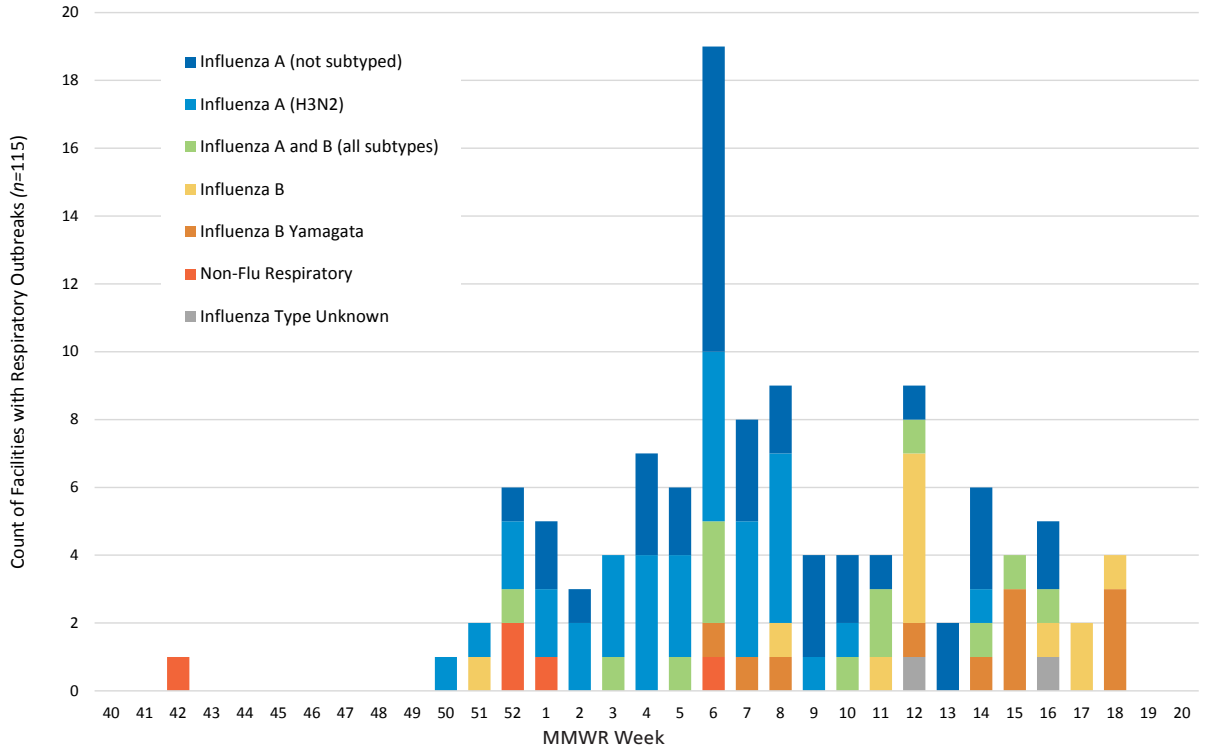


TABLE 2: RESPIRATORY OUTBREAKS IN CONGREGATE LIVING FACILITIES, BY INFLUENZA STRAIN, 2016-2017 INFLUENZA SEASON

	Respiratory Outbreaks (N=115)	
Influenza Type	**N**	**%**
Influenza A (not subtyped)	37	32.2%
Influenza A (H3N2)	35	30.4%
Influenza A and B (all subtypes)	13	11.3%
Influenza B	12	10.4%
Influenza B Yamagata	11	9.6%
Non-Influenza Respiratory	5	4.3%
Influenza Type Unknown	2	1.7%

During the 2016-2017 influenza season, there were 115 discrete outbreaks of respiratory illness in congregate living facilities. The predominant viruses identified in these outbreaks were Influenza A (not subtyped) (32.2% of all outbreaks) and Influenza A (H3N2) (30.4% of all outbreaks). The 2016-2017 influenza season had nearly a three-fold increase in the number of respiratory outbreaks over the 2015-2016 influenza season, which had 40 respiratory outbreaks. Influenza A (H3N2) viruses, circulating in in 2016-2017, are associated with high numbers of infections and outbreaks among older populations. In the 2015-2016 influenza season, the predominant strain of influenza was Influenza A (H1N1) 2009, which is not as frequently associated with severe disease in elderly individuals. The difference in circulating viruses likely accounts for the greater number of outbreaks in the 2016-2017 influenza season. This number of outbreaks is most similar to the 2014-2015 influenza season, the most recent season with circulating Influenza A (H3N2) viruses. In the 2014-2015 influenza season, there were 140 respiratory outbreaks in congregate living settings.

Some congregate living facilities experienced multiple outbreaks during the 2016-2017 influenza season; the total of 115 respiratory outbreaks occurred in 84 different congregate living facilities. Of the 115 outbreaks, 80 outbreaks (69.6%) occurred in long-term care facilities (facilities with skilled nursing services), and 26 outbreaks (22.6%) occurred in assisted living facilities. The remaining nine outbreaks (7.8%) were divided among other congregate living settings, such as universities, hospitals, boarding schools, and adult day programs. Attack rates for respiratory illness within each facility were calculated by dividing the number of residents with ILI or influenza at each facility by the total number of residents living in the facility. The mean attack rate was 6.8%, and the median attack rate was 4.9%. Attack rates ranged from 0.3% in a university to 30% in one long-term care facility. Facilities with outbreaks self-reported vaccination rates among residents. Older adults are a well-vaccinated population throughout the US, with an early 2016-2017 influenza vaccination coverage estimate of 56.6% of adults age 65 or older receiving vaccine[9]. Among congregate living settings in Rhode Island, vaccine coverage was even higher. The mean reported resident vaccination rate in congregate settings with outbreaks was 88.3%, and the median rate was 90.8%. Out of the 111 outbreaks for which vaccination coverage estimates were available, 56.8% of outbreaks occurred in facilities with 90% or higher vaccine coverage.

INFLUENZA-RELATED MORTALITY

An influenza-associated death is defined, for surveillance purposes, as a death resulting from a clinically compatible illness that was confirmed to be influenza by an appropriate laboratory or rapid diagnostic test. There should be no period of complete recovery between the illness and death. Adult influenza-associated deaths became reportable by regulation in Rhode Island in 2013, and pediatric influenza-associated deaths have been nationally reportable since 2006.

FIGURE 14: INFLUENZA-ASSOCIATED DEATHS BY STRAIN AND MMWR WEEK, RHODE ISLAND, 2016-2017 INFLUENZA SEASON

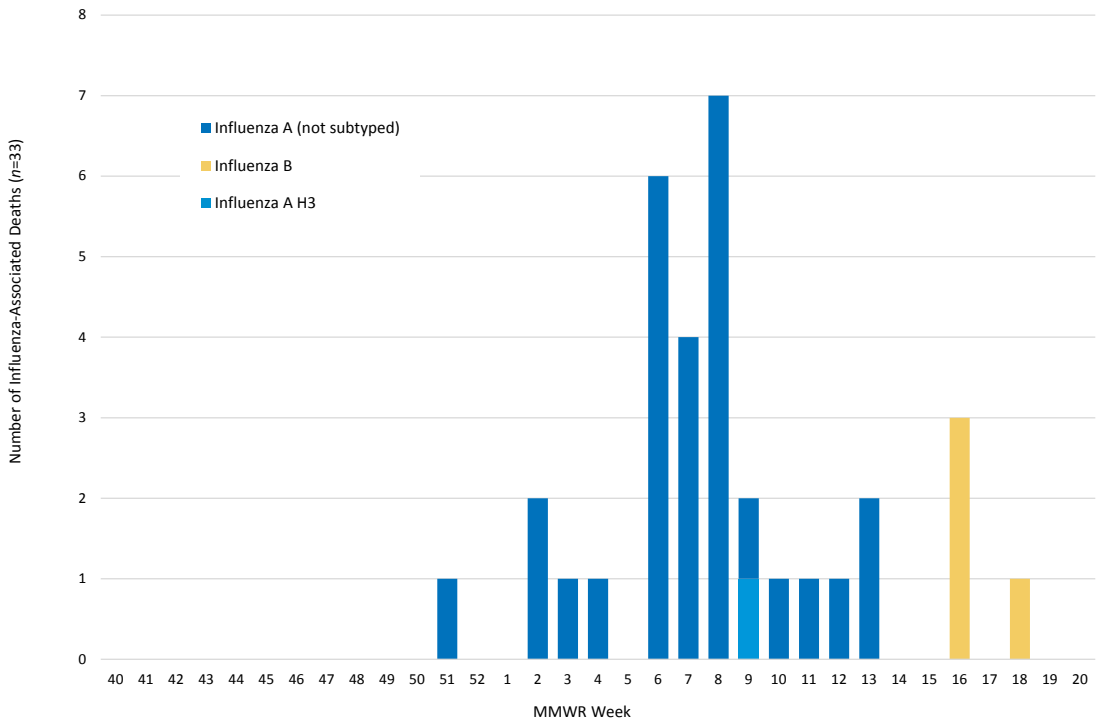
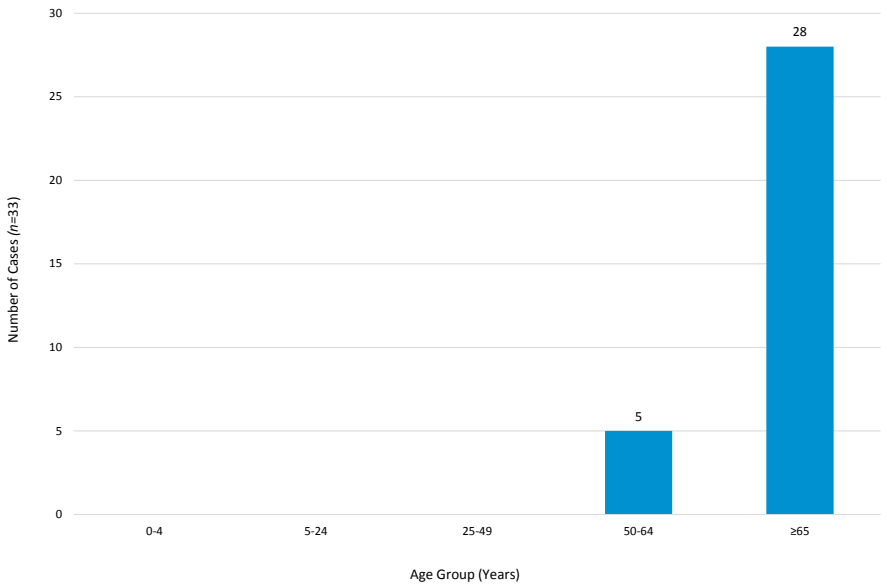


FIGURE 15: INFLUENZA-ASSOCIATED DEATHS BY AGE GROUP, RHODE ISLAND, 2016-2017 INFLUENZA SEASON



During the 2016-2017 season, 33 adult influenza-associated deaths were reported to RIDOH. There were no pediatric influenza-associated deaths in the 2016-2017 season. The number of deaths per week was the greatest during the three peak weeks of the influenza season: MMWR Weeks 6-8 (February 5-25, 2017). Most deaths (87.9%) were associated with Influenza A viruses, and most viruses were not subtyped. In the last 5 weeks of the influenza season, there were four deaths (12.1% of influenza-associated deaths) associated with Influenza B viruses.

Compared to the 2015-2016 influenza season, during which 14 deaths were reported to RIDOH, the 2016-2017 influenza season had significantly more influenza-associated deaths. This difference is consistent with the severity associated with the circulating influenza viruses in each season. In the 2016-2017 influenza season, the main circulating viruses were Influenza A (H3N2), which are associated with increased hospitalizations and mortality, particularly in comparison to the Influenza A (H1N1) 2009 viruses that were predominant in the 2015-2016 influenza season.

Most deaths (84.8%) in the 2016-2017 influenza season occurred in adults age 65 and older, with the remaining deaths occurring in adults between the ages of 50 and 64. No deaths were reported in individuals younger than 50. The mean age of adult influenza-related deaths was 80 years, and median age was 87 years. Individuals who died ranged in age from 50-97 years. The median age of influenza deaths in the 2016-2017 season (87 years) was 20 years older than the median age of deaths in the 2015-2016 influenza season (65 years).

Most influenza-associated deaths in 2016-2017 occurred in individuals with underlying medical conditions. Health conditions reported at time of death included chronic obstructive pulmonary disease (COPD), hypertension, diabetes, renal disease, congestive heart failure, dementia, lung cancer, coronary artery disease, asthma, stroke, and cerebral palsy. Individuals with these and other underlying conditions are known to be at high risk for developing influenza-related complications that may ultimately result in mortality[10].

During the 2016-2017 influenza season, RIDOH began collecting influenza vaccination information on individuals with influenza-associated death. Vaccination status was only available for 16 out of the 33 influenza-associated deaths. Eleven of these 16 individuals (68.8%) had received influenza vaccine during the 2016-2017 influenza season.

REAL-TIME OUTBREAK AND DISEASE (RODS) SURVEILLANCE

The Real-Time Outbreak and Disease Surveillance system (RODS) monitors chief complaints from hospital emergency departments in Rhode Island. The data are analyzed based on syndrome to detect patterns of disease outbreaks. While there is no specific syndrome for influenza-related visits, an increase in ILI is most likely to trigger an alert for constitutional syndrome, which consists of chief complaints of fever, myalgia, or influenza. Therefore, constitutional syndrome is used as a proxy for ILI. RODS triggers alerts based on algorithms that detect unexpected increases in the number of visits to emergency departments for constitutional syndrome.

FIGURE 16: PERCENTAGE OF ALL EMERGENCY DEPARTMENT VISITS DUE TO CONSTITUTIONAL SYNDROME BY MMWR WEEK, RHODE ISLAND HOSPITALS, 2016-2017 INFLUENZA SEASON

The syndromic surveillance data for the 2016-2017 influenza season followed the trends of the ILI and hospitalization data, with the percentage of constitutional syndrome visits peaking around Week 6.

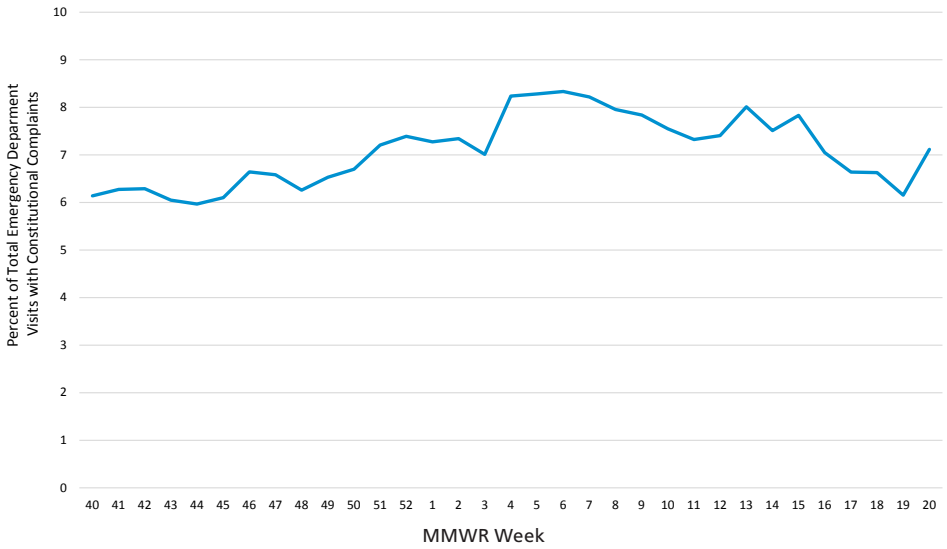
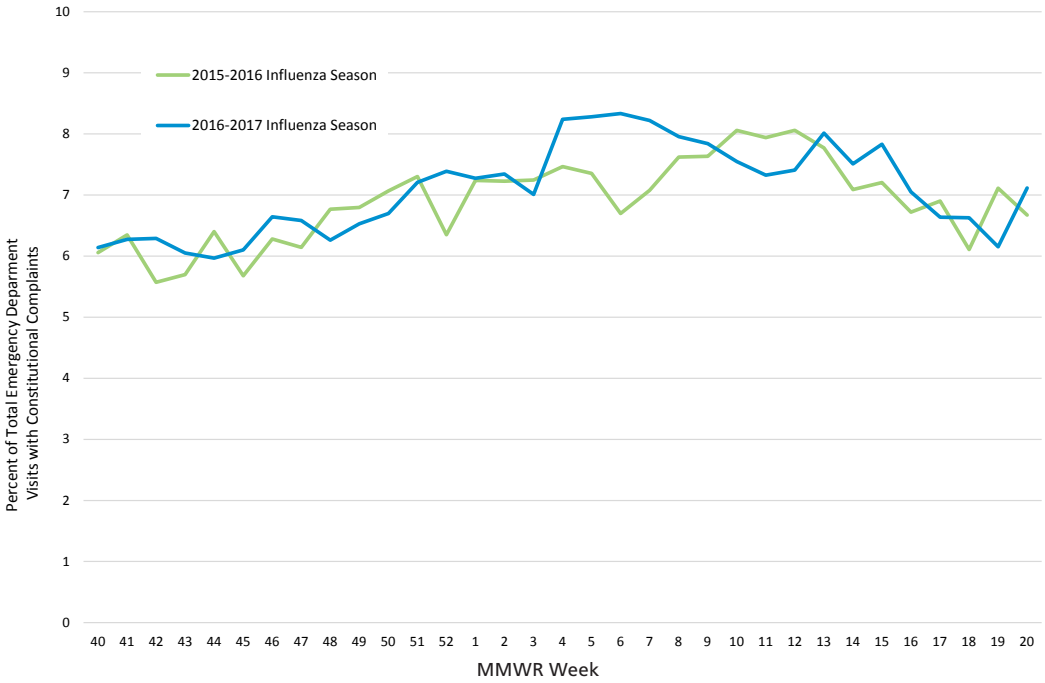


FIGURE 17: PERCENTAGE OF ALL EMERGENCY DEPARTMENT VISITS DUE TO CONSTITUTIONAL SYNDROME BY MMWR WEEK, RHODE ISLAND HOSPITALS, COMPARISON OF 2016-2017 AND 2015-2016 INFLUENZA SEASONS

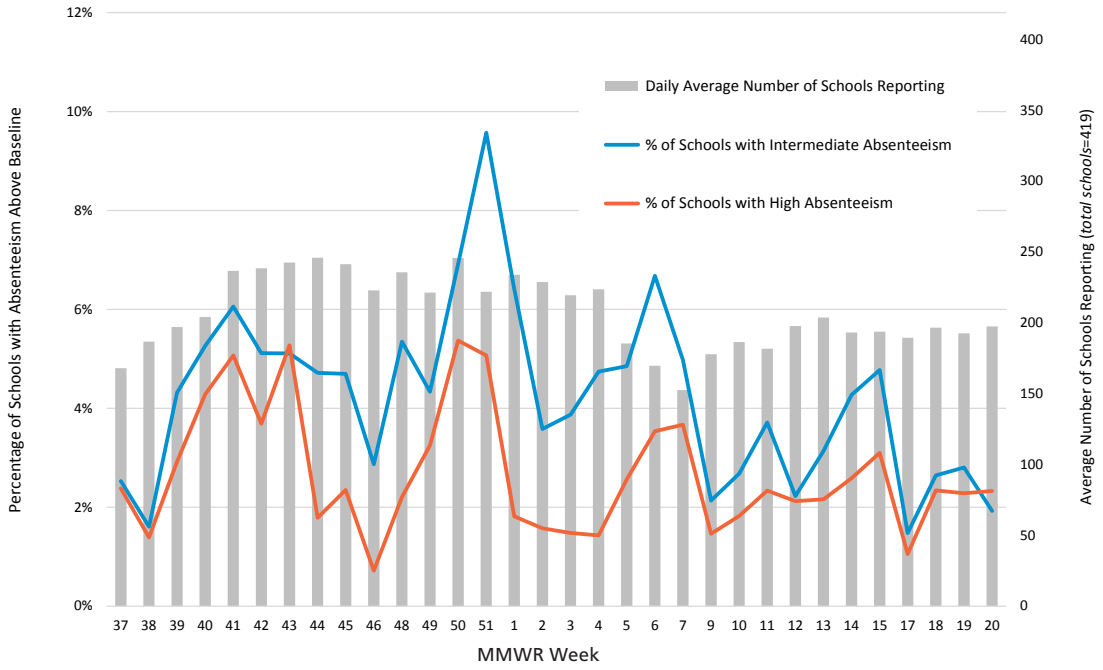


Compared to the 2015-2016 influenza season, constitutional complaints in the 2016-2017 seasons showed an earlier peak with a slightly higher magnitude.

SCHOOL ABSENTEEISM

Increases above normal trends in absenteeism from school can serve as an indicator of influenza activity within a school. In an effort to detect outbreaks, RIDOH monitors school absenteeism data reported by K-12 schools (public, private, and parochial) to the Rhode Island Department of Education. If higher-than-expected school absenteeism rates are detected within a school for three consecutive days, RIDOH contacts the school nurse teacher, inquires about the reason for the increased absenteeism, and reviews infection control measures should ILI be the reason for the increased absenteeism.

FIGURE 18: LEVEL OF SCHOOL ABSENTEEISM AND NUMBERS OF SCHOOLS REPORTING, 2016-2017 SCHOOL YEAR



In the 2016-2017 school year, an average of 210 schools out of 419 total schools reported weekly (range: 153-246 schools). A school with high absenteeism is defined as an absenteeism rate higher than 200% of a school's baseline absenteeism rate for a given day. During the 2016-2017 school year, the weekly percentage of schools with high absenteeism oscillated, with multiple peaks and valleys. One peak occurred from MMWR Weeks 6-7 (February 5-18, 2017), which coincided with the peak of the influenza season (MMWR Weeks 6-8 [February 5-25, 2017]). Another peak occurred during MMWR Weeks 50-51 (December 11-24, 2016), the weeks adjacent to school vacation.

A school with intermediate absenteeism is defined as an absenteeism rate between 100%-199% of a school's baseline absenteeism rate for a given day. During the 2016-2017 school year, the weekly average percentage of schools with intermediate absenteeism peaked in MMWR Week 51 (December 18-24, 2016), with 9.6% of schools reporting intermediate absenteeism.

School absenteeism can be a marker of circulating illness in school-aged children, but not all increases in absenteeism are due to influenza, or to illness at all. Impending school vacations, adverse weather, "Senior Skip" days, and terror threats can all impact school attendance. In addition, the school year is interspersed with school holidays, and, at times, snow days. To control for these factors, weeks with school vacations or multiple days of weather cancellation were omitted from analysis. Analysis of school absenteeism data helps RIDOH maintain situational awareness of trends within the student population.

CONCLUSION

The 2016-2017 influenza season was a moderate influenza season, with greater numbers of hospitalizations, respiratory outbreaks, and deaths than the 2015-2016 influenza season. The 2016-2017 influenza season also had higher rates of ILI than the 2015-2016 influenza season. The 2016-2017 influenza season had an atypical three-week peak in both ILI and positive hospital influenza tests in MMWR Weeks 6-8 (February 5-25, 2017), as well as a secondary peak due to Influenza B viruses in MMWR Weeks 12-14 (March 19-April 8, 2017). The predominant influenza virus circulating during the 2016-2017 influenza season was Influenza A (H3N2), although there were significant numbers of infections due to Influenza B viruses, particularly in the second half of the season. The circulating strains of influenza remained well-matched to the 2016-2017 seasonal influenza vaccine.

In partnership with community agencies, RIDOH maintains a strong, multi-faceted influenza surveillance system that informs understanding and decision-making not only at the individual physician-patient level, but also at local, statewide, and national levels.

LIMITATIONS

This report is subject to several limitations. Unlike many other infectious diseases, individual cases of influenza are not reportable to RIDOH; only outbreaks of respiratory illness and influenza-associated deaths are reportable. An exact count of the number of influenza cases in Rhode Island is not maintained. Instead, data are collected from several sources using a group of surveillance systems, each with its own strengths and limitations. Data from ILINet illustrate geographic spread of ILI within the state but do not provide data on severity of disease or laboratory-confirmed influenza. In contrast, hospitalization data describe severity of influenza illness, but do not provide information on geographic spread. Respiratory outbreak surveillance provides data on the impact of influenza on Rhode Island's congregate living facility residents, and allows for the implementation of control measures. The RIDOH State Health Laboratories provide highly accurate molecular testing, but the samples it receives are often pre-screened, and thus the percent of positive tests does not have a meaningful denominator. Finally, RODS data are syndromic, providing data on trends in emergency department chief complaints, but not measuring influenza or ILI specifically.

While each component of the surveillance system is vital, no single component can be solely relied upon to gather comprehensive data on influenza in Rhode Island. To perform complete surveillance of influenza, RIDOH draws upon the strengths of each system to compensate for the limits of others. In addition, RIDOH relies upon voluntary partnerships with sentinel sites and hospitals to report high-quality data.

APPENDIX A.
DESCRIPTION OF DATA SOURCES

RIDOH maintains a network of influenza surveillance systems. These surveillance systems are designed to monitor influenza activity and ILI, assess and measure the burden of influenza infections within the community, characterize circulating influenza strains, and detect novel influenza viruses. In Rhode Island, the following surveillance systems are used to accomplish these goals:

Outpatient Influenza-Like Illness Surveillance Network (ILINet): RIDOH participates in an influenza sentinel surveillance program known as ILINet. It is a collaborative effort among the Centers for Disease Control and Prevention (CDC), state health departments, and ILINet sites within each state. Providers for ILINet are recruited annually by state health departments. For the 2016-2017 influenza season, 17 providers were enrolled in the program. These consisted of six family practices, four student health centers, four pediatric practices, two internal medicine practices, and one urgent care center (Appendix B)

Each week, ILINet providers report data to RIDOH and CDC on the total number of patients seen for any reason and the number of those patients presenting with ILI. ILI is defined as a fever (≥ 100° F or 37.8°C) and cough and/or sore throat in the absence of a known cause other than influenza. These data are aggregated by age group (0-4 years, 5-24 years, 25-49 years, 50-64 years, and ≥65 years).

Providers participating in ILINet are also responsible for routinely submitting nine nasopharyngeal swabs per influenza season from ILI patients to RSHL for clinical confirmation, molecular subtyping, and lineage testing.

RIDOH State Health Laboratories Virology Surveillance: The RSHL, a World Health Organization (WHO) accredited laboratory, types, subtypes, and performs lineage testing on influenza specimens from ILINet providers, congregate living facilities, and the Office of the State Medical Examiners. RSHL maintains the capacity to detect all circulating strains of influenza, using the CDC Human Influenza Virus Real-Time RT-PCR Diagnostic Panel (CDC Flu rRT-PCR DX Panel Catalog #FluIVD03) and the Influenza B Genotyping Assay (#FluIVD03-4). Any specimen unable to be subtyped is perceived to be a variant strain and is forwarded to CDC for testing.

Hospital Surveillance: Hospital laboratories throughout the state conduct routine diagnostic tests for influenza via molecular assays and rapid diagnostic tests. Demographic and clinical information on influenza-positive patients, and aggregate numbers of influenza tests conducted are sent to RIDOH on a weekly basis. Inpatient hospitalization data are also collected as part of this surveillance.

Real-time Outbreak and Disease Surveillance system (RODS): This syndromic surveillance system allows real-time monitoring of chief complaint data from patients upon arrival in emergency departments of several syndromes that include respiratory, constitutional, gastrointestinal, hemorrhagic, and neurologic. Constitutional symptoms most closely resemble those of influenza (fever, myalgia, or chief compliant of influenza), and are used as a proxy for influenza presentation.

Influenza-Associated Mortality: An influenza-associated death is defined, for surveillance purposes, as a death resulting from a clinically compatible illness that was confirmed to be influenza by an appropriate laboratory or rapid diagnostic test. There should be no period of complete recovery between the illness and death. Since 2006, influenza-associated pediatric deaths have been nationally reportable to CDC. Adult influenza-associated deaths became reportable by regulation in Rhode Island in 2013.

School Absenteeism: In an effort to detect outbreaks, RIDOH monitors school absenteeism data reported through the Rhode Island Department of Education. Staff at RIDOH calculate baseline rates of absenteeism for each school, based on previous years and months of absenteeism rates. If higher than expected baseline school absenteeism rates are detected for three consecutive days, RIDOH contacts the school nurse teacher, inquires about the reason for the increased absenteeism, and reviews infection control measures should ILI be the reason for the increased absenteeism.

APPENDIX B.
ILINET SENTINEL PARTICIPANTS

RIDOH greatly appreciates the efforts of all our ILINet providers and their staff. These ILINet providers generate data for much of the influenza surveillance program and for the information presented in this report. Participating providers for the 2016-2017 influenza season are listed below.

Data Sources: Rhode Island Geographic Information Systems - RIGIS, Rhode Island Deprtment of Health

SENTINEL PROVIDERS

1. Anchor Medical Associates
   Lincoln
2. Well One Primary Medical
   Burrillville
3. Rhode Island College Health Services
   Providence
4. Bryant University Health Center
   Smithfield
5. Brown University Health Center
   Providence
6. Coastal Waterman Pediatrics
   East Providence
7. Blackstone Valley Pediatrics
   Cumberland
8. University Medicine Foundation
   Warwick
9. East Greenwich Pediatrics, Inc.
   East Greenwich
10. Warren Family Practice
    Warren
11. Aquidnick Medical Associates, Inc.
    Newport
12. East Bay Family Healthcare
    Newport
13. South County Internal Medicine
    South Kingstown
14. University of Rhode Island Health Services
    South Kingstown
15. South County Walk-in & Primary Care
    Narragansett
16. Well One Primary Medical and Dental
    North Kingstown
17. Dr. Stuart Demirs
    Charlestown

APPENDIX C.
INFLUENZA ACTIVITY LEVEL DEFINITIONS

The statewide influenza activity, also known as geographic spread, is reported to CDC each week. The determination of the activity is made using the following algorithm, provided by CDC.

ACTIVITY LEVEL DEFINITIONS

Activity Level	ILI activity*/Outbreaks		Laboratory data
No activity	Low	AND	No lab confirmed cases†
Sporadic	Not increased	AND	Isolated lab-confirmed case(s)
		OR	
	Not increased	AND	Lab confirmed outbreak in one institution‡
Local	Increased ILI in 1 region**; ILI activity in other regions is not increased	AND	Recent (within the past 3 weeks) lab evidence of influenza in region with increased ILI
		OR	
	2 or more institutional outbreaks (ILI or lab confirmed) in 1 region; ILI activity in other regions is not increased	AND	Recent (within the past 3 weeks) lab evidence of influenza in region with the outbreaks; virus activity is no greater than sporadic in other regions
Regional (doesn't apply to states with ≤4 regions)	Increased ILI in ≥2 but less than half of the regions	AND	Recent (within the past 3 weeks) lab confirmed influenza in the affected regions
		OR	
	Institutional outbreaks (ILI or lab confirmed) in ≥2 and less than half of the regions	AND	Recent (within the past 3 weeks) lab confirmed influenza in the affected regions
Widespread	Increased ILI and/or institutional outbreaks (ILI or lab confirmed) in at least half of the regions	AND	Recent (within the past 3 weeks) lab confirmed influenza in the state.

*ILI activity can be assessed using a variety of data sources including ILINet providers, school/workplace absenteeism, and other syndromic surveillance systems that monitor influenza-like illness.

† Lab confirmed case = case confirmed by rapid influenza diagnostic test, antigen detection, culture, or PCR.

‡ Institution includes nursing home, hospital, prison, school, etc.

**Region: population under surveillance in a defined geographical subdivision of a state.

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ACKNOWLEDGEMENTS

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Special thanks to:

Anne Berg; Aaron Frechette; Annemarie Beardsworth, CCPH; Jason Garrett, BSN, MPH; Normand Laliberte, BSN, RN; Karen Luther, RN, MPH; Patricia McAuley, RN, MSN, CIC; Chuck McGinnis, BSN, RN; Kaley O'Connor; Ashley Truong; Sarah Hart Shuford, MPH

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10/2017