Interim Adjusted Estimates of Seasonal Influenza Vaccine Effectiveness — United States, February 2013

Early influenza activity during the 2012–13 season (*1*) enabled estimation of the unadjusted effectiveness of the seasonal influenza vaccine (*2*). This report presents updated adjusted estimates based on 2,697 children and adults enrolled in the U.S. Influenza Vaccine Effectiveness (Flu VE) Network during December 3, 2012–January 19, 2013. During this period, overall vaccine effectiveness (VE) (adjusted for age, site, race/ethnicity, self-rated health, and days from illness onset to enrollment) against influenza A and B virus infections associated with medically attended acute respiratory illness was 56%, similar to the earlier interim estimate (62%) (*2*). VE was estimated as 47% against influenza A (H3N2) virus infections and 67% against B virus infections. When stratified by age group, the point estimates for VE against influenza A (H3N2) and B infections were largely consistent across age groups, with the exception that lower VE against influenza A (H3N2) was observed among adults aged ≥65 years. These adjusted VE estimates indicate that vaccination with the 2012–13 influenza season vaccine reduced the risk for outpatient medical visits resulting from influenza by approximately one half to two thirds for most persons, although VE was lower and not statistically significant among older adults. Antiviral medications should be used as recommended for treatment of suspected influenza in certain patients, including those aged ≥65 years, regardless of their influenza vaccination status.

Details of the VE network design, sites, and enrollment procedures have been described previously (*2,3*). In this report, patients aged ≥6 months seeking outpatient medical care for an acute respiratory illness with cough, within 7 days of illness onset, were enrolled at five study sites.* Consenting participants completed an enrollment interview. Nasal and oropharyngeal swabs were combined and tested using CDC's real-time reverse transcription–polymerase chain reaction (rRT-PCR) protocol. Participants were considered vaccinated if they had received ≥1 dose of any seasonal influenza vaccine ≥14 days before illness onset, according to medical records and registries (at Texas, Washington, and Wisconsin sites) or self-report (at Michigan and Pennsylvania sites).

Of the 2,697 children and adults enrolled during December 3, 2012–January 19, 2013, a total of 1,115 (41%) tested positive for influenza virus by rRT-PCR (Figure). The proportion of patients with influenza differed by study site, sex, age group, race/ethnicity, self-rated health status, and interval from illness onset to enrollment (Table 1). The proportion vaccinated ranged from 36% to 54% across sites and also differed by sex, age group, race/ethnicity, and self-rated health status (Table 1).

Among the patients with influenza, 32% had been administered the 2012–13 seasonal influenza vaccine, compared with 50% of the influenza-negative controls (Table 2). For all persons with medically attended acute respiratory illness, the overall VE (adjusted for age group, study site, race/ethnicity, self-rated health status, and days from illness onset to enrollment) against influenza A and B virus infections was 56% (95% confidence interval [CI] = 47%–63%) (Table 2). Significant VE against influenza A and B viruses was observed among persons in all age groups, except for adults aged ≥65 years.

Among the 751 infections with influenza A viruses, 560 (75%) had been subtyped; 546 (98%) of the infections were caused by influenza A (H3N2) viruses (Table 1). The adjusted VE for all ages against influenza A (H3N2) virus infection was 47% (CI = 35%–58%) (Table 2). The adjusted, age-stratified VE point estimates were 58% for persons aged 6 months–17 years, 46% for persons aged 18–49 years, 50% for persons aged 50–64 years, and 9% for persons aged ≥65 years (Table 2).

A total of 366 (33%) of the 1,115 cases had infections caused by influenza B viruses (Table 1). The adjusted VE estimate for all ages against influenza B was 67% (51%–78%) (Table 2). The adjusted VE point estimates against influenza B ranged from 64% to 75% across age groups.

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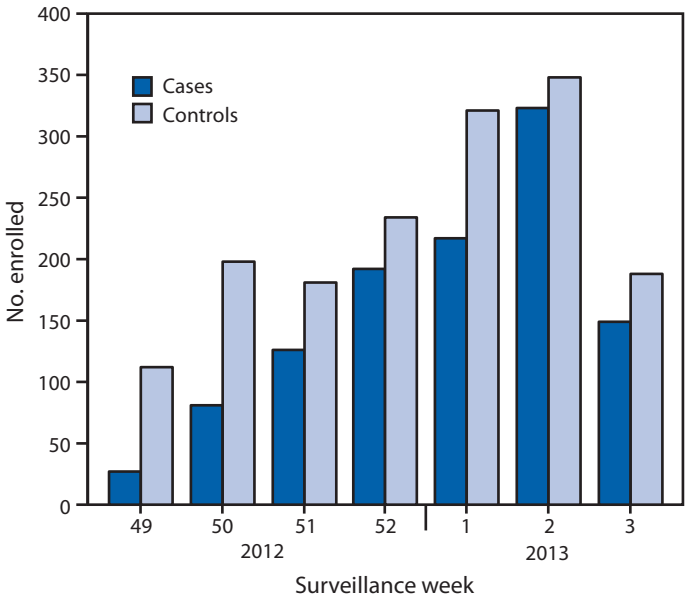
* The five network sites and the dates enrollment began were as follows: Group Health Cooperative (Seattle, Washington) (December 26, 2012); the Marshfield Clinic Research Foundation (Marshfield, Wisconsin) (December 17, 2012); the University of Michigan School of Public Health, partnered with the University of Michigan Health System (Ann Arbor, Michigan) (December 17, 2012) and the Henry Ford Health System (Detroit, Michigan) (January 2, 2013); the University of Pittsburgh Schools of the Health Sciences, partnered with the University of Pittsburgh Medical Center (Pittsburgh, Pennsylvania) (December 3, 2012); and Scott and White Healthcare (Temple, Texas) (December 9, 2012).

FIGURE. Numbers of influenza-positive cases and influenza-negative controls, by surveillance week of illness onset — U.S. Influenza Vaccine Effectiveness Network, United States, December 3, 2012–January 19, 2013



* Week 3 includes only patients with completed laboratory tests and thus does not reflect all enrolled patients during that week across study sites.

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Editorial Note

These updated and age-adjusted VE estimates for the 2012–13 influenza vaccine confirm moderate effectiveness in preventing outpatient medical visits caused by circulating influenza viruses, similar to earlier unadjusted estimates in the United States (*2*) and to recent interim estimates from Canada and Europe (*4,5*). Overall, influenza vaccination reduced the risk for medical visits resulting from influenza A and B by 56%, from influenza A (H3N2) by 47%, and from influenza B by 67%. The preventive benefits against influenza B were consistent across age groups. The adjusted VE estimates against influenza A (H3N2) viruses also were largely consistent (46%–58%) for persons aged 6 months–64 years, but the estimate was not significant among persons aged ≥65 years. These VE estimates are not final; an increased sample size and adjustment for additional potential confounders (such as chronic medical conditions and functional status) at the end of the season could change these estimates.

Confirmation of the protective benefits of the 2012–13 influenza vaccine among persons aged 6 months–64 years offers further support for the public health benefit of annual seasonal influenza vaccination and supports the expansion of vaccination, particularly among younger age groups. The nonsignificant adjusted VE of 9% against A (H3N2) among persons aged ≥65 years is similar to the estimate in a recent interim report from Europe (*6*) and reinforces the need for continued advances in influenza vaccines, especially to increase protective benefits for older adults.

One possible explanation for these findings is that some older adults did not mount an effective immune response to the influenza A (H3N2) component of this season's vaccine. Nonetheless, this finding should not discourage future vaccination by persons aged ≥65 years, who are at greater risk for more severe cases and complications from influenza. Influenza vaccines remain the best preventive tool available, and VE is known to vary by virus type/subtype, age group, season, host immunity, and the outcome measured (*7*). This study observed a VE point estimate against influenza B (67%) that was much higher than the 9% VE estimate against A (H3N2) among older adults, although the precision of estimates was limited by the small sample. Although some previous studies have shown influenza vaccine benefits for older adults, others have failed to demonstrate statistically significant benefits against specific influenza types or subtypes (*7*). Variability among studies and across seasons and age groups is to be expected and should not change recommendations for annual vaccination. It is also important to note that the VE estimates in this report are limited to the prevention of outpatient medical visits, rather than more severe illness outcomes, such as hospitalization or death. A previous multiseason study found that the influenza vaccine reduced the risk for influenza-associated hospitalizations among older adults by 61% (CI = 18%–82%) (*8*). A full evaluation of the VE for older adults this season must await consideration of additional data and outcomes.

TABLE 1. Selected characteristics for enrolled patients with medically attended acute respiratory illness, by infuenza test result status and seasonal influenza vaccination status — U.S. Influenza Vaccine Effectiveness Network,* United States, December 3, 2012–January 19, 2013

	Test result status					Vaccination status		
	Influenza-negative		Influenza-positive			Vaccinated§		
Characteristic	No.	(%)	No.	(%)	p-value†	No./Total	(%)	p-value†
Overall	**1,582**	**(100)**	**1,115**	**(100)**		**1,160/2,697**	**(43)**	
Study site					**<0.001**			**<0.001**
Michigan	257	(16)	138	(12)		**168/395**	(43)	
Pennsylvania	360	(23)	208	(18)		**251/568**	(44)	
Texas	452	(29)	251	(23)		**254/703**	(36)	
Washington	173	(11)	90	(8)		**142/263**	(54)	
Wisconsin	340	(22)	428	(39)		**345/768**	(44)	
Sex					**0.358**			**0.006**
Male	629	(40)	463	(42)		**435/1,092**	(40)	
Female	953	(60)	652	(58)		**725/1,605**	(45)	
Age group (yrs)					**<0.001**			**<0.001**
6 mos–8	379	(24)	261	(23)		**275/640**	(43)	
9–17	186	(12)	202	(18)		**118/388**	(30)	
18–49	604	(38)	353	(32)		**356/957**	(37)	
50–64	248	(16)	174	(16)		**206/422**	(49)	
≥65	165	(10)	125	(11)		**205/290**	(71)	
Race/Ethnicity¶					**0.006**			**0.012**
White	1,191	(75)	885	(80)		**922/2076**	(44)	
Hispanic	154	(10)	94	(8)		**88/248**	(36)	
Black	137	(9)	60	(5)		**72/197**	(37)	
Other race	100	(6)	76	(7)		**78/176**	(44)	
Self-rated health status					**<0.001**			**<0.001**
Fair or poor	138	(9)	68	(6)		**104/206**	(50)	
Good	405	(26)	236	(21)		**297/641**	(46)	
Very good	557	(35)	378	(34)		**424/935**	(45)	
Excellent	482	(30)	433	(39)		**335/915**	(37)	
Illness onset to enrollment (days)					**<0.001**			**0.061**
<3	544	(34)	504	(45)		**441/1,048**	(42)	
3–4	653	(41)	410	(37)		**442/1,063**	(42)	
5–7	385	(24)	201	(18)		**277/586**	(47)	
Influenza test result								
Negative	1,582	(100)	—	—		**793/1,582**	(50)	
Influenza B positive**	—	—	366	(33)		**90/366**	(25)	
Influenza A positive**	—	—	751	(67)		**277/751**	(37)	
A (H1N1)pdm	—	—	14	(2)		**2/14**	(14)	
A (H3N2)	—	—	546	(73)		**211/546**	(39)	
A subtype pending	—	—	191	(15)		**64/191**	(34)	

Abbreviation: rRT-PCR = real-time reverse transcription–polymerase chain reaction.

* The five network sites and the dates enrollment began were as follows: Group Health Cooperative (Seattle, Washington) (December 26, 2012); the Marshfield Clinic Research Foundation (Marshfield, Wisconsin) (December 17, 2012); the University of Michigan School of Public Health, partnered with the University of Michigan Health System (Ann Arbor, Michigan) (December 17, 2012) and the Henry Ford Health System (Detroit, Michigan) (January 2, 2013); the University of Pittsburgh Schools of the Health Sciences, partnered with the University of Pittsburgh Medical Center (Pittsburgh, Pennsylvania) (December 3, 2012); and Scott and White Healthcare (Temple, Texas) (December 9, 2012).

† Chi-square testing was used to assess differences between persons with influenza-negative and influenza-positive test results and in the distribution of enrolled patient and illness characteristics and also to assess differences between groups in the percentage vaccinated.

§ Defined as having received ≥1 dose of vaccine ≥14 days before illness onset. To date, 92% of influenza vaccines administered to participants have been inactivated. A total of 40 participants who received the vaccine ≤13 days before illness onset were excluded from the study sample because of uncertain immunization status.

¶ Enrollees were categorized into one of four mutually exclusive racial/ethnic populations: white, black, other race, and Hispanic. Persons identified as Hispanic might be of any race. Persons identified as white, black, or other race are non-Hispanic. The overall prevalences calculated included data from all racial/ethnic groups, not just the three included in this analysis.

** Two case-patients had coinfections with influenza A and B, making the sum 1,117, or two greater than the total number of influenza positives.

Clinicians should maintain a high index of suspicion for influenza infection among persons with acute respiratory illness while influenza activity is ongoing. Early antiviral treatment can reduce influenza-associated illness severity and complications (*9*); this season, antiviral treatment of elderly adults is especially important.† CDC recommends initiating

† A CDC influenza update for geriatricians and other clinicians caring for persons aged ≥65 years is available at http://www.cdc.gov/flu/professionals/2012-2013-guidance-geriatricians.htm.

TABLE 2. Number and percentage receiving 2012–13 seasonal trivalent influenza vaccine among 2,697 outpatients with acute respiratory illness and cough, by influenza test result status, age group, and vaccine effectiveness* against all influenza A and B and against virus types A (H3N2) and B — U.S. Influenza Vaccine Effectiveness Network,† United States, December 3, 2012–January 19, 2013

	Influenza-positive		Influenza-negative		Vaccine effectiveness			
					Unadjusted		Adjusted	
Influenza type/Age group	No. vaccinated/ Total	(%)	No. vaccinated/ Total	(%)	(%)	(95% CI)	(%)	(95% CI)
Influenza A and B								
Overall	**367/1,115**	**(33)**	**793/1,582**	**(50)**	**(51)**	**(43–58)**	**(56)**	**(47–63)**
Age group (yrs)								
6 mos–17	118/463	(26)	275/565	(49)	(64)	(53–72)	(64)	(51–73)
18–49	100/353	(28)	256/604	(42)	(46)	(29–60)	(52)	(38–79)
50–64	63/174	(36)	143/248	(58)	(58)	(38–72)	(63)	(43–76)
≥65	86/125	(69)	119/165	(72)	(15)	(-42 to 49)	(27)	(-31 to 59)
Influenza A (H3N2) only								
Overall	**211/544**	**(39)**	**793/1,582**	**(50)**	**(37)**	**(23–48)**	**(47)**	**(35–58)**
Age group (yrs)								
6 mos–17	52/179	(29)	275/565	(49)	(57)	(38–70)	(58)	(38–71)
18–49	53/183	(29)	256/604	(42)	(45)	(21–61)	(46)	(20–63)
50–64	41/96	(43)	143/248	(58)	(45)	(12–66)	(50)	(15–71)
≥65	65/86	(76)	119/165	(72)	(-20)	(-118 to 34)	(9)	(-84 to 55)
Influenza B only								
Overall	**90/364**	**(25)**	**793/1,582**	**(47)**	**(67)**	**(58–77)**	**(67)**	**(51–78)**
Age group (yrs)								
6 mos–17	59/230	(26)	275/565	(49)	(64)	(49–74)	(64)	(46–75)
18–49	17/79	(22)	256/604	(42)	(63)	(35–79)	(68)	(40–83)
50–64	8/40	(20)	143/248	(58)	(82)	(59–92)	(75)	(39–90)
≥65	6/15	(40)	119/165	(72)	(74)	(24–91)	(67)	(-10 to 90)

Abbreviation: CI = confidence interval.

* Vaccine effectiveness was estimated as 100% x (1 – odds ratio [ratio of odds of being vaccinated among outpatients with influenza-positive test results to the odds of being vaccinated among outpatients with influenza-negative test results]); odds ratios were estimated using logistic regression.

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antiviral medications for patients with suspected influenza, regardless of their influenza vaccination status, if they are aged ≥65 years, or hospitalized, or have progressive or complicated illness, or otherwise are at higher risk for complications from influenza.§ Antiviral treatment can be initiated empirically, preferably within 48 hours after illness onset, and should not be delayed pending confirmatory diagnostic testing nor be dependent upon tests with limited sensitivity (e.g., negative rapid tests). Among hospitalized patients, treatment should be initiated on admission; several studies suggest effectiveness of antiviral treatment even when initiated ≥48 hours after illness onset (*9*).

The findings in this report are subject to at least four limitations. First, the observational study design has greater potential for confounding and bias relative to randomized clinical trials. Second, although these midseason VE estimates were adjusted for potential confounders identified in previous studies (*3*), additional factors will be considered in final end-of-season estimates, including health-care–seeking behavior, differences in functional status, and severity of illness, which could influence VE estimates, especially for older adults. Third, no adjustment was made for chronic medical conditions, because of a lack of medical record data for interim analyses; however, VE estimates were adjusted for self-rated health, which is associated with chronic illness and mortality risk (*10*). Finally, the immunization status of young children (which requires vaccine histories) and vaccine product information (e.g., inactivated compared with live attenuated) also were unavailable for this interim analysis. End-of-season VE estimates could change as additional patient data become available or if circulating viruses or population immunity change over the remainder of the season.

Although imperfect, influenza vaccines remain the best tool currently available for preventing illness from influenza. This report highlights the value of both increasing the use of

§ Guidance for clinicians on antiviral use is available at http://www.cdc.gov/flu/professionals/antivirals/summary-clinicians.htm.

What is already known on this topic?

Annual vaccination is the mainstay of influenza prevention, but overall effectiveness of the influenza vaccine is moderate and varies by year, virus type, and population subgroup. Early unadjusted interim estimates of overall vaccine effectiveness (VE) for the 2012–13 season indicated the vaccine was 62% effective among all ages at preventing medically attended, laboratory-confirmed influenza A and B virus infections.

What is added by this report?

This report provides updated and adjusted VE estimates for the 2012–13 influenza season based on data from 2,697 children and adults with acute respiratory illness enrolled in the U.S. Influenza Vaccine Effectiveness (Flu VE) Network during December 3, 2012–January 19, 2013. The overall VE (adjusted for age group, study site, race/ethnicity, self-rated health status, and days from illness onset to enrollment) for all ages at preventing medically attended influenza A and B virus infections was 56% (95% confidence interval = 47%–63%). VE was estimated at 47% against influenza A (H3N2) virus infections and 67% against influenza B virus infections. VE against influenza A (H3N2) was lower and not statistically significant among adults aged ≥65 years.

What are the implications for public health practice?

The 2012–13 seasonal influenza vaccine provides substantial protection for the population overall, which underscores the public health value of vaccination. Nonetheless, some vaccinated persons have become ill with influenza this season, especially among persons aged ≥65 years. Antiviral medications are an important second line of defense against influenza and should be used promptly, as recommended for treatment of suspected influenza in certain patients in high-risk groups, including those aged ≥65 years, regardless of their vaccination status.

influenza vaccines, especially among children and young adults, and continuing efforts to develop more effective vaccines and vaccination strategies. Antiviral medications are important for the treatment and control of influenza and should be used as recommended, regardless of patient vaccination status.

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References

1. CDC. Fluview. 2012–2013 influenza season week 3 ending January 19, 2013. Atlanta, GA: US Department of Health and Human Services, CDC; 2013. Available at http://www.cdc.gov/flu/weekly/weeklyarchives 2012-2013/weekly03.htm.
2. CDC. Early estimates of seasonal influenza vaccine effectiveness—United States, January 2013. MMWR 2013;62:32–5.
3. Treanor J, Talbot HK, Ohmit SE, et al. Effectiveness of seasonal influenza vaccines in the United States during a season with circulation of all three vaccine strains. Clin Infect Dis 2012;55:951–9.
4. McMenamin J, Andrews N, Robertson C, et al. Effectiveness of seasonal 2012/13 vaccine in preventing laboratory-confirmed influenza infection in primary care in the United Kingdom: mid-season analysis 2012/13. Euro Surveill 2013;18(5).
5. Skowronski DM, Janjua NZ, De Serres G, et al. Interim estimates of influenza vaccine effectiveness in 2012/13 from Canada's sentinel surveillance network, January 2013. Euro Surveill 2013;18(5).
6. Bragstad K, Emborg HD, Kølsen Fischer T, et al. Low vaccine effectiveness against influenza A (H3N2) virus among elderly people in Denmark in 2012/13—a rapid epidemiological and virological assessment. Euro Surveill 2013;18(6).
7. Osterholm MT, Kelley NS, Sommer A, Belongia EA. Efficacy and effectiveness of influenza vaccines: a systematic review and meta-analysis. Lancet Infect Dis 2012;12:36–44.
8. Talbot HK, Griffin MR, Chen Q, Zhu Y, Williams JV, Edwards KM. Effectiveness of seasonal vaccine in preventing confirmed influenza-associated hospitalizations in community dwelling older adults. J Infect Dis 2011;203:500–8.
9. CDC. Antiviral agents for the treatment and chemoprophylaxis of influenza: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR 2011;60(No. RR-1).
10. Singh-Manoux A, Martikainen P, Ferrie J, Zins M, Marmot M, Goldberg M. What does self rated health measure? Results from the British Whitehall II and French Gazel cohort studies. J Epidemiol Community Health 2006;60:364–72.

Update: Influenza Activity — United States, September 30, 2012–February 9, 2013

Influenza activity in the United States began to increase in mid-November and remained elevated through February 9, 2013. During that time, influenza A (H3N2) viruses predominated overall, followed by influenza B viruses. This report summarizes U.S. influenza activity* since the beginning of the 2012–13 influenza season and updates the previous summary (*1*).

Viral Surveillance

During September 30, 2012–February 9, 2013, approximately 140 World Health Organization (WHO) and National Respiratory and Enteric Virus Surveillance System collaborating laboratories in the United States tested 203,706 respiratory specimens for influenza viruses; 55,470 (27.2%) were positive (Figure 1). Of these, 44,035 (79%) were influenza A viruses, and 11,435 (21%) were influenza B viruses. Of the 44,035 influenza A viruses, 29,914 (68%) were subtyped; 29,091 (97%) of these were influenza A (H3) viruses, and 823 (3%) were influenza A (H1N1)pdm09 (pH1N1) viruses. The percentage of specimens testing positive for influenza increased through the week ending December 29, 2012 (week 52), when 38.1% tested positive, and decreased subsequently. In the week ending February 9, 2013 (week 6), 19.7% of specimens tested positive. Since the start of the influenza season to February 9, 2013, influenza A (H3) viruses predominated in the United States overall, followed by influenza B viruses, while pH1N1 viruses were identified less frequently.

Novel Influenza A Viruses

One infection with an influenza A (H3N2) variant virus (H3N2v) was reported to CDC during the week ending December 8, 2012 (week 49) from Minnesota. Close contact between the patient and swine in the week preceding illness was reported. The patient fully recovered, and no further cases were identified in contacts of the patient. This is the second H3N2v infection reported for the 2012–13 influenza season (*1*).

* The CDC influenza surveillance system collects five categories of information from eight data sources: 1) viral surveillance (U.S. World Health Organization collaborating laboratories, the National Respiratory and Enteric Virus Surveillance System, and novel influenza A virus case reporting); 2) outpatient illness surveillance (U.S. Outpatient Influenza-Like Illness Surveillance Network); 3) mortality (122 Cities Mortality Reporting System and influenza-associated pediatric mortality reports); 4) hospitalizations (FluSurv-NET, which includes the Emerging Infections Program and surveillance in five additional states); and 5) summary of the geographic spread of influenza (state and territorial epidemiologist reports).

Antigenic Characterization

WHO collaborating laboratories in the United States are requested to submit a subset of their influenza-positive respiratory specimens to CDC for further antigenic characterization. CDC has antigenically characterized 1,088 influenza viruses collected during the 2012–13 season, including 86 pH1N1, 677 influenza A (H3N2), and 325 influenza B viruses. All pH1N1 viruses were characterized as A/California/7/2009-like (H1N1), which is the 2012–13 influenza A (H1N1) component of the 2012–13 Northern Hemisphere vaccine. A total of 673 (99.4%) of the 677 influenza A (H3N2) viruses were characterized as A/Victoria/361/2011-like (H3N2), the influenza A (H3N2) component of the 2012–13 Northern Hemisphere vaccine. Of the 325 influenza B viruses tested, 230 (71%) belong to the B/Yamagata lineage and were characterized as B/Wisconsin/1/2010-like, the influenza B component of the 2012–13 Northern Hemisphere vaccine; 95 (29%) of the influenza B viruses tested belong to the B/Victoria lineage of viruses.

Antiviral Resistance of Influenza Virus Isolates

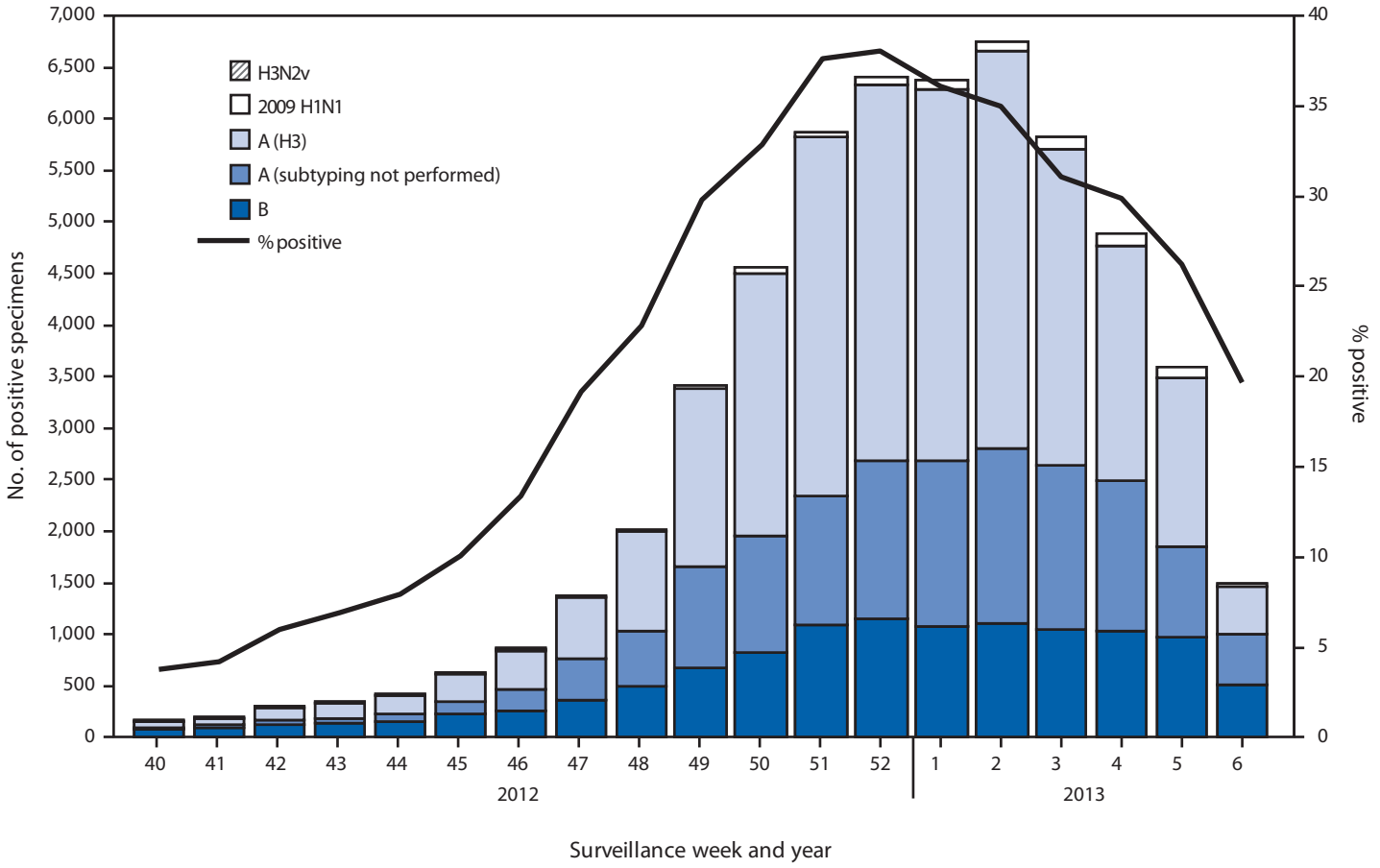
Since October 1, 2012, a total of 1,702 influenza viruses have been tested for resistance to influenza antiviral medications. None of the 1,072 influenza A (H3N2) or the 396 influenza B viruses was resistant to either oseltamivir or zanamivir. Among 234 pH1N1 viruses tested for resistance to oseltamivir, two (0.9%) were found to be resistant, and of the 97 viruses tested for resistance to zanamivir, none were found to be resistant, including one of the two oseltamivir-resistant pH1N1 viruses. Additional laboratory testing, including testing for resistance to zanamvir, is pending on the second oseltamivir-resistant pH1N1 virus. High levels of resistance to the adamantanes persist among pH1N1 and influenza A (H3N2) viruses.

Outpatient Illness Surveillance

Since September 30, 2012, the weekly percentage of outpatient visits for influenza-like illness (ILI)† reported by approximately 1,900 U.S. Outpatient ILI Surveillance Network (ILINet) providers in 50 states, New York City, Chicago, the U.S. Virgin Islands, and the District of Columbia that comprise ILINet, has ranged from 1.2% to 6.1%. From the week ending November 24, 2012 (week 47) to February 9, 2013 (week 6),

† Defined as a temperature ≥100°F (≥37.8°C), oral or equivalent, and cough or sore throat, without a known cause other than influenza.

FIGURE 1. Number and percentage of respiratory specimens testing positive for influenza, by type, surveillance week, and year — U.S. World Health Organization and National Respiratory and Enteric Virus Surveillance System collaborating laboratories, United States, 2012–13 influenza season



the percentage equaled or exceeded the national baseline[§] of 2.2% for 12 consecutive weeks (Figure 2). During the 1997–98 through 2011–12 seasons, peak weekly percentages of outpatient visits for ILI ranged from 2.4% to 7.7% and remained above baseline levels for an average of 12 weeks (range: 1–18 weeks). For the week ending February 9, 2013 (week 6), all 10 U.S. Department of Health and Human Services regions[¶] continued to report ILI activity above region-specific baseline levels.

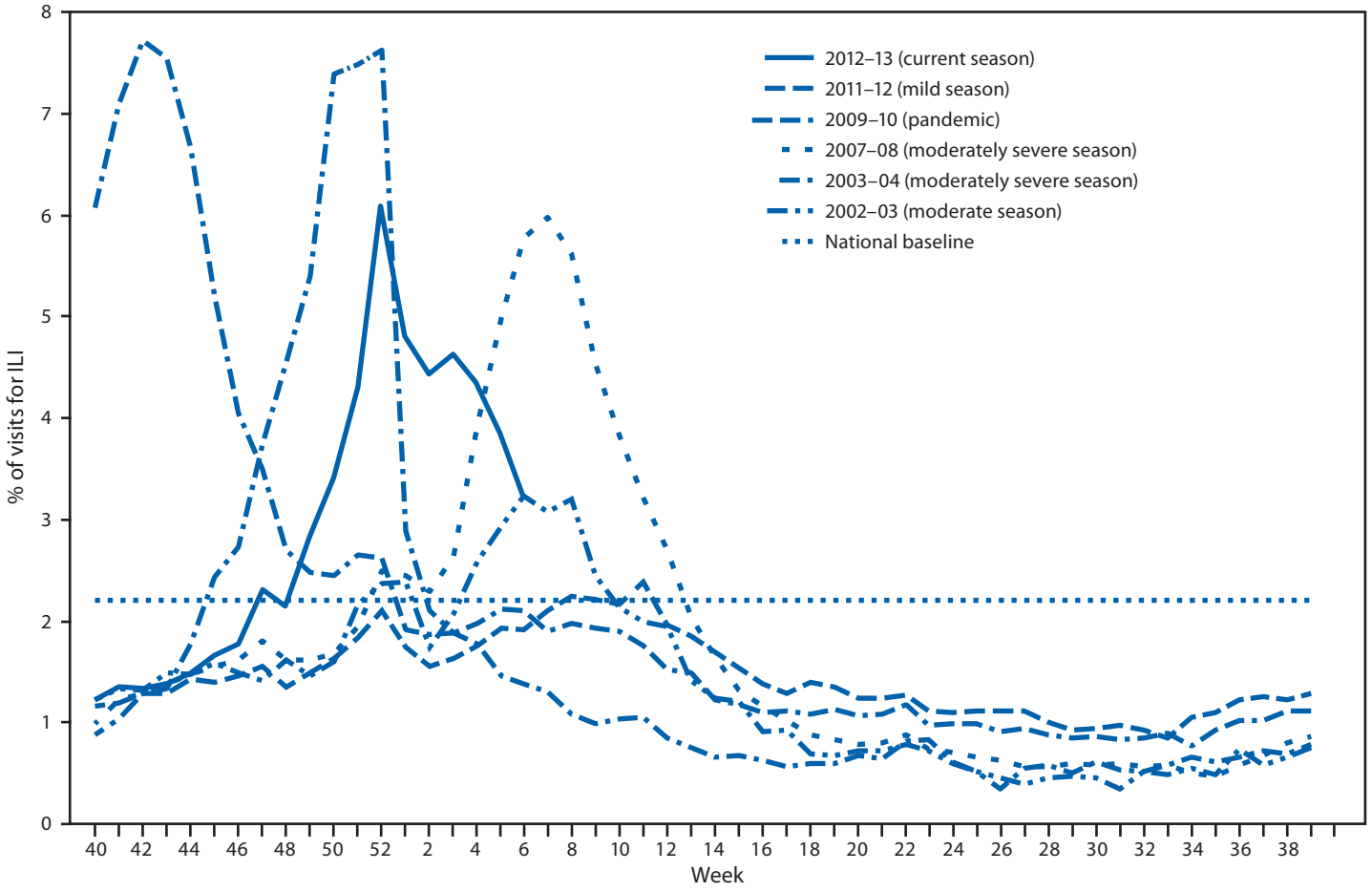
Data collected in ILINet are used to produce a measure of ILI activity[**] by jurisdiction. During the week ending February 9, 2013 (week 6), 11 states and New York City experienced high ILI activity (Alabama, California, Idaho, Kansas, Michigan, Missouri, Nevada, New Jersey, Texas, Utah, and Vermont), 10 states experienced moderate ILI activity (Arizona, Colorado, Illinois, Indiana, Louisiana, Minnesota, North Dakota, Oregon, South Dakota, and Virginia), 13 states and the District of Columbia experienced low ILI activity (Arkansas, Florida, Georgia, Hawaii, Iowa, Massachusetts, Mississippi, Nebraska, New Mexico, New York, Oklahoma, Washington, and Wyoming), and 16 states experienced minimal ILI

[§] The national and regional baselines are the mean percentage of visits for ILI during noninfluenza weeks for the previous three seasons plus two standard deviations. Noninfluenza weeks are defined as periods of 2 or more consecutive weeks in which each week accounted for less than 2% of the season's total number of specimens that tested positive for influenza. National and regional percentages of patient visits for ILI are weighted on the basis of state population. Use of the national baseline for regional data is not appropriate.

[¶] The 10 regions include the following jurisdictions: *Region 1*: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; *Region 2*: New Jersey, New York, Puerto Rico, and the U.S. Virgin Islands; *Region 3*: Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia; *Region 4*: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee; *Region 5*: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin; *Region 6*: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas; *Region 7*: Iowa, Kansas, Missouri, and Nebraska; *Region 8*: Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming; *Region 9*: Arizona, California, Hawaii, Nevada, American Samoa, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Marshall Islands, and Republic of Palau; and *Region 10*: Alaska, Idaho, Oregon, and Washington.

[**] Activity levels are based on the percentage of outpatient visits in a state attributed to ILI and are compared with the average percentage of ILI visits that occur during weeks with little influenza virus circulation. Activity levels range from minimal, which would correspond to ILI activity from outpatient clinics being at or below the average, to high, which would correspond to ILI activity from outpatient clinics being much higher than the average.

FIGURE 2. Percentage of visits for influenza-like illness (ILI) reported by the U.S. Outpatient Influenza-Like Illness Surveillance Network (ILINet), by surveillance week and year — United States, 2012–13 and selected previous influenza seasons*



* Data as of February 16, 2013.

activity (Alaska, Connecticut, Delaware, Kentucky, Maine, Maryland, Montana, New Hampshire, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, West Virginia, and Wisconsin). As of February 9, 2013, the largest total number of jurisdictions experiencing high ILI activity in a single week occurred during the week ending December 29, 2012 (week 52), when a total of 33 states and New York City experienced high ILI activity. The total number of jurisdictions experiencing high ILI activity in a single week during the 2008–09 through 2011–12 influenza seasons has ranged from four to 18 jurisdictions, excluding the 2009 pandemic, when 44 jurisdictions reported high ILI activity (CDC, unpublished data, 2013).

Geographic Spread of Influenza

For the week ending February 9, 2013 (week 6), the geographic spread of influenza[††] was reported as widespread in 31 states (Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Missouri, Montana, New Hampshire, New Jersey, New Mexico, New

[††] Levels of activity are 1) no activity; 2) sporadic: isolated laboratory-confirmed influenza cases or a laboratory-confirmed outbreak in one institution, with no increase in activity; 3) local: increased ILI, or at least two institutional outbreaks (ILI or laboratory-confirmed influenza) in one region of the state, with recent laboratory evidence of influenza in that region; virus activity no greater than sporadic in other regions; 4) regional: increased ILI activity or institutional outbreaks (ILI or laboratory-confirmed influenza) in at least two but less than half of the regions in the state with recent laboratory evidence of influenza in those regions; and 5) widespread: increased ILI activity or institutional outbreaks (ILI or laboratory-confirmed influenza) in at least half the regions in the state, with recent laboratory evidence of influenza in the state.

York, Ohio, Oklahoma, Oregon, Pennsylvania, Utah, Virginia, Washington, Wisconsin, and Wyoming), regional in Puerto Rico and 14 states (Alabama, Hawaii, Kentucky, Louisiana, Minnesota, Nebraska, Nevada, North Dakota, South Carolina, South Dakota, Tennessee, Texas, Vermont, and West Virginia), and local in the District of Columbia and four states (Georgia, Mississippi, North Carolina, and Rhode Island). Sporadic influenza activity was reported by Guam and one state (Delaware), and the U.S. Virgin Islands did not report. As of February 9, 2013, the number of jurisdictions reporting influenza activity as widespread peaked during the week ending January 12, 2013 (week 2), when a total of 48 jurisdictions reported influenza activity as widespread. The number of states reporting widespread activity during the peak week of activity has ranged from 25 to 49 states during the previous five influenza seasons (CDC, unpublished data, 2013).

Influenza-Associated Hospitalizations

CDC monitors hospitalizations associated with laboratory-confirmed influenza infection in adults and children through the Influenza Hospitalization Surveillance Network (FluSurv-NET),[§§] which covers approximately 9% of the U.S. population. From October 1, 2012, to February 9, 2013, a total of 8,953 laboratory-confirmed influenza associated hospitalizations were reported, with a cumulative incidence for all age groups of 32.1 per 100,000 population. The most affected age group was persons aged ≥65 years, accounting for more than 50% of reported influenza-associated hospitalizations. The cumulative hospitalization rate (per 100,000 population) from October 1, 2012, to February 9, 2013, was 44.0 among children aged 0–4 years, 9.3 among children aged 5–17 years, 11.6 among adults 18–49 years, 29.4 among adults aged 50–64 years, and 146.2 among adults aged ≥65 years (Figure 3). During the past three influenza seasons (2009–10 through 2011–12), end-of-season age-specific cumulative hospitalization rates ranged from 14.8 to 73.0 per 100,000 population for ages 0–4 years, 4.0 to 27.3 for ages 5–17 years, 4.1 to 23.3 for ages 18–49 years, 8.3 to 30.4 for ages 50–64 years, and 25.3 to 64.0 for ages ≥65 years. During the 2005–06 to the 2008–09 influenza seasons, end-of-season hospitalization rates among adults aged ≥65 years ranged from 13.5 to 73.8 per 100,000 population.

For the current season, the most commonly reported underlying medical conditions among hospitalized adults were cardiovascular disease, metabolic disorders, obesity, and chronic lung disease (excluding asthma). The most commonly reported underlying medical conditions in hospitalized children were asthma, neurologic disorders, and immune suppression. Forty-four percent of hospitalized children had no identified underlying medical conditions that place them at higher risk for influenza complications.[¶¶] Among 218 hospitalized women of childbearing age (15–44 years), 63 (29%) were pregnant.

Pneumonia and Influenza-Associated Mortality

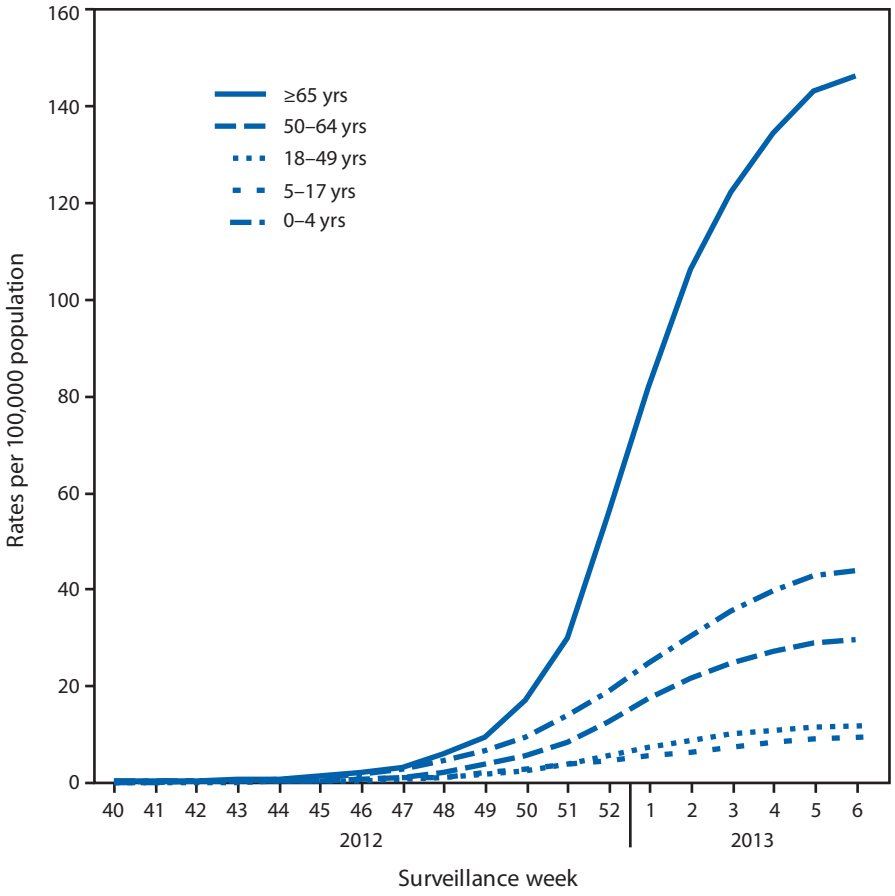
For the week ending February 9, 2013 (week 6), pneumonia and influenza (P&I) was reported as an underlying or contributing cause of death for 9.1% of all deaths reported to the 122 Cities Mortality Reporting System (Figure 4). This percentage is above the epidemic threshold of 7.5% for that week.[***] Since September 30, 2012, the weekly percentage of deaths attributed to P&I ranged from 5.8% to 9.9%, and, as of February 9, 2013 (week 6), had exceeded the epidemic threshold for 6 consecutive weeks (weeks ending January 5–February 9, 2013 [weeks 1–6]). As of February 9, 2013, the weekly percentage of deaths attributed to P&I peaked at 9.9% during the week ending January 19, 2013 (week 3). Peak weekly percentages of deaths attributed to P&I in the previous five seasons ranged

[§§] FluSurv-NET conducts population-based surveillance for laboratory-confirmed influenza-associated hospitalizations in children aged <18 years (since the 2003–04 influenza season) and adults aged ≥18 years (since the 2005–06 influenza season). The FluSurv-NET covers approximately 80 counties in the 10 Emerging Infections Program states (California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon, and Tennessee) and additional Influenza Hospitalization Surveillance Project (IHSP) states. IHSP began during the 2009–10 season to enhance surveillance during the 2009 H1N1 pandemic. IHSP sites included Iowa, Idaho, Michigan, Oklahoma, and South Dakota during the 2009–10 season; Idaho, Michigan, Ohio, Oklahoma, Rhode Island, and Utah during the 2010–11 season; Michigan, Ohio, Rhode Island, and Utah during the 2011–12 season; and Iowa, Michigan, Ohio, Rhode Island, and Utah during the 2012–13 season. Incidence rates are calculated using CDC's National Center for Health Statistics population estimates for the counties included in the surveillance catchment area. Laboratory confirmation is dependent on clinician-ordered influenza testing, and testing for influenza often is underutilized because of the poor reliability of rapid test results and greater reliance on clinical diagnosis for influenza. As a consequence, cases identified as part of influenza hospitalization surveillance likely are an underestimation of the actual number of persons hospitalized with influenza.

[¶¶] Persons at higher risk include children aged <5 years (especially those aged <2 years); adults aged ≥65 years; persons with chronic pulmonary (including asthma), cardiovascular (except hypertension alone), renal, hepatic, hematologic (including sickle cell disease), or metabolic disorders (including diabetes mellitus), or neurologic and neurodevelopment conditions (including disorders of the brain, spinal cord, peripheral nerve, and muscle, such as cerebral palsy, epilepsy [seizure disorders], stroke, intellectual disability [mental retardation], moderate to severe developmental delay, muscular dystrophy, or spinal cord injury); persons with immunosuppression, including that caused by medications or by human immunodeficiency virus infection; women who are pregnant or postpartum (within 2 weeks after delivery); persons aged ≤18 years who are receiving long-term aspirin therapy; American Indian/Alaska Natives; persons who are morbidly obese (i.e., body mass index ≥40); and residents of nursing homes and other chronic-care facilities.

[***] The seasonal baseline proportion of P&I deaths is projected using a robust regression procedure in which a periodic regression model is applied to the observed percentage of deaths from P&I that were reported by the 122 Cities Mortality Reporting System during the preceding 5 years. The epidemic threshold is set at 1.645 standard deviations above the seasonal baseline.

FIGURE 3. Rates of hospitalization for laboratory-confirmed influenza, by age group and surveillance week — FluSurv-NET,* 2012–13 influenza season†



* FluSurv-NET conducts population-based surveillance for laboratory-confirmed influenza-associated hospitalizations in children aged <18 years (since the 2003–04 influenza season) and adults aged ≥18 years (since the 2005–06 influenza season). The FluSurv-NET covers approximately 80 counties in the 10 Emerging Infections Program states (California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon, and Tennessee) and additional Influenza Hospitalization Surveillance Project states (Iowa, Michigan, Ohio, Rhode Island, and Utah).

† Data as of February 16, 2013.

from 7.9% for the 2008–09 and 2011–12 seasons to 9.1% during the 2007–08 and 2010–11 seasons.

Influenza-Associated Pediatric Mortality

As of February 9, 2013, a total of 64 laboratory-confirmed influenza-associated pediatric deaths occurring during the 2012–13 season had been reported to CDC from Chicago, New York City, and 27 states. The mean and median ages of children reported to have died were 7.9 and 7.4 years, respectively; three children were aged <6 months, 11 were aged 6–23 months, eight were aged 2–4 years, 24 were aged 5–11 years, and 18 were aged 12–17 years. Of the 64 deaths, 16 were associated with influenza A (H3N2) virus infection, 19 deaths were associated with an influenza A virus infection that was not subtyped, and 29 deaths were associated with influenza B infection. Since 2004, when CDC began collection of influenza-associated pediatric death data, each season approximately 20% of children aged ≥6 months who were eligible to receive seasonal influenza vaccination and died from influenza-associated complications had received the seasonal influenza vaccine (CDC, unpublished data, 2013). Since influenza-associated pediatric mortality became a nationally notifiable disease in 2004, the total number of influenza-associated pediatric deaths has ranged from 34 to 122 per season; excluding the 2009 pandemic, when 348 pediatric deaths were reported to CDC during April 15, 2009, through October 2, 2010.

Reported by

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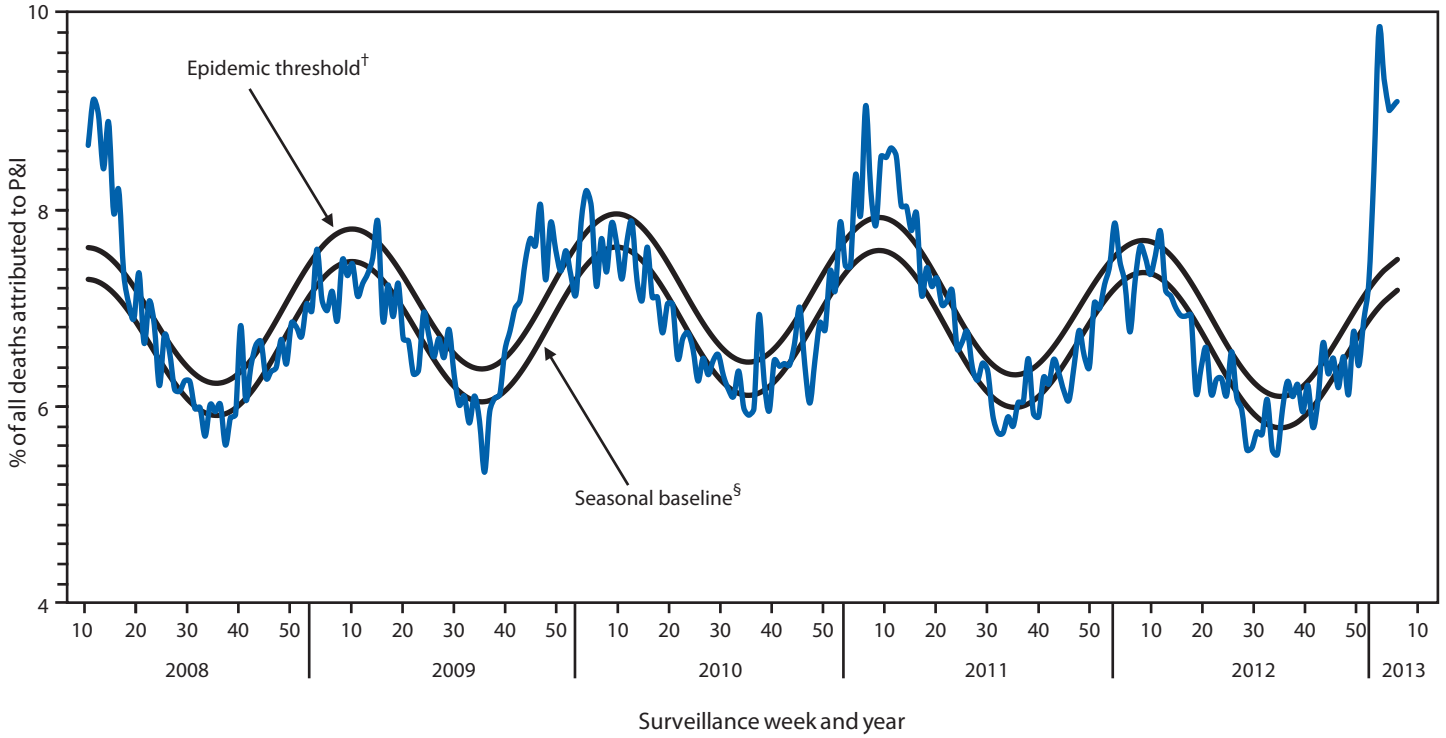
Editorial Note

The 2012–13 influenza season began early, and influenza activity remained elevated across the United States as of February 9, 2013; during the most recent weeks, decreases have been observed in the South and East, while increases have continued in the West. Although the timing of influenza activity is not predictable, substantial activity can occur as late as May (*2*). During September 30, 2012–February 9, 2013, influenza A (H3N2) viruses were identified most frequently, followed by influenza B viruses, but a small number of pH1N1 viruses also were reported. Antigenic characterization of influenza-positive respiratory specimens submitted to CDC indicated that the majority of these specimens were like the 2012–13 influenza vaccine components. As of February 9, 2013, more than half of influenza-associated hospitalizations were reported to have occurred in adults aged ≥65 years, and rates of influenza-associated hospitalization

FIGURE 4. Percentage of all deaths attributable to pneumonia and influenza (P&I), by surveillance week and year — 122 U.S. Cities Mortality Reporting System, United States, 2008–2013*



* For the reporting week ending February 9, 2013.
† The epidemic threshold is 1.645 standard deviations above the seasonal baseline.
§ The seasonal baseline is projected using a robust regression procedure that applies a periodic regression model to the observed percentage of deaths from P&I during the preceding 5 years.

What is already known on this topic?

CDC collects, compiles, and analyzes data on influenza activity year-round in the United States. The timing and severity of circulating influenza viruses can vary by geographic location and season.

What is added by this report?

Influenza activity in the United States began to increase in mid-November and remained elevated through February 9, 2013. During September 30, 2012–February 9, 2013, of 55,470 influenza viruses tested, 79% were influenza A, and 19% were influenza B. Of 29,914 influenza A viruses that were subtyped, 97% were H3N2, and 3% were pH1N1. The age group with the highest hospitalization rate was ≥65 years, accounting for more than half of all reported influenza-associated hospitalizations.

What are the implications for public health practice?

Year-round influenza surveillance provides critical information for planning interventions to prevent and control influenza, developing vaccine recommendations and antiviral treatment guidance, and presenting information to the public regarding the progress and severity of the influenza season.

among adults aged ≥65 years increased sharply from late December through January. The weekly percentage of deaths attributed to P&I was above the epidemic threshold beginning early in January, with the majority of the P&I deaths occurring in adults aged ≥65 years.

In the past, higher overall and age-specific rates of hospitalization and mortality have been observed during influenza A (H3N2)–predominant seasons (*3,4*). Based on FluSurv-Net surveillance data for the 2012–13 season to date, rates of influenza-associated hospitalizations are highest among adults aged ≥65 years, followed by children aged 0–4 years. This trend is similar to that observed in the 2007–08 and 2010–11 influenza seasons, during which influenza A (H3N2) viruses predominated. The number and rate of influenza-associated hospitalizations among adults aged ≥65 years during the 2012–13 influenza season is the highest since data collection on laboratory-confirmed influenza-associated hospitalization in adults began in the 2005–06 season.

Vaccination remains the first and best way to prevent influenza and its complications. Health-care providers should continue to offer vaccine to all unvaccinated persons aged ≥6

months throughout the influenza season. Interim vaccine effectiveness estimates suggest that effectiveness against influenza A (H3N2) viruses is lower and not statistically significant in adults aged ≥65 years during the 2012–13 influenza season (*5*). Adults aged ≥65 years are at the greatest risk for hospitalization and death from influenza-associated complications; therefore, it is important for them to receive their annual influenza vaccine, take everyday preventive actions, and seek medical care quickly if they develop ILI symptoms to see if treatment with antiviral medications is needed. Antiviral medications remain an important adjunct to vaccination for reducing the health impact of influenza. Recommended antiviral medications are oseltamivir and zanamivir. Early and aggressive treatment with antiviral medication is crucial, ideally within the first 48 hours of illness onset, and persons with suspected influenza infection who are at high risk, including adults aged ≥65 years, should be treated with antiviral medications without the need to wait for laboratory confirmation of influenza (*6*). However, as indicated by observational studies, antiviral treatment might still be beneficial in patients with severe, complicated, or progressive illness and in hospitalized patients when started after 48 hours of illness onset (*6*). Recent data on influenza antiviral resistance indicate that >99% of currently circulating influenza virus strains are sensitive to these medications.

Influenza surveillance reports for the United States are posted online weekly and are available at http://www.cdc.gov/flu/weekly. Additional information regarding influenza viruses, influenza surveillance, influenza vaccine, influenza antiviral medications, and novel influenza A infections in humans is available at http://www.cdc.gov/flu.

Acknowledgments

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References

1. CDC. Update: influenza activity—United States, September 30–November 24, 2012. MMWR 2012;61:990–3.
2. CDC. Prevention and control of influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR 2010;59(No. RR-8).
3. Dao CN, Kamimoto L, Nowell M, et al. Adult hospitalizations for laboratory-positive influenza during the 2005–2006 through 2007–2008 seasons in the United States. J Infect Dis 2010;202:881–8.
4. Thompson WW, Shay DK, Weintrab E, et al. Mortality associated with influenza and respiratory syncytial virus in the United States. JAMA 2003;289:179–86.
5. CDC. Interim adjusted estimates of seasonal influenza vaccine effectiveness—United States, February 2013. MMWR 2013;62:120–4.
6. CDC. Antiviral agents for the treatment and chemoprophylaxis of influenza: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR 2011;60(No. RR-1).