Centers for Disease Control and Prevention

MMWR

Morbidity and Mortality Weekly Report

Weekly / Vol. 64 / No. 30

August 7, 2015

School Start Times for Middle School and High School Students — United States, 2011–12 School Year

Anne G. Wheaton, PhD[1]; Gabrielle A. Ferro, PhD[1]; Janet B. Croft, PhD[1]

Adolescents who do not get enough sleep are more likely to be overweight (*1*); not engage in daily physical activity (*2*); suffer from depressive symptoms (*2*); engage in unhealthy risk behaviors such as drinking, smoking tobacco, and using illicit drugs (*2*); and perform poorly in school (*3*). However, insufficient sleep is common among high school students, with less than one third of U.S. high school students sleeping at least 8 hours on school nights (*4*). In a policy statement published in 2014, the American Academy of Pediatrics (AAP) urged middle and high schools to modify start times as a means to enable students to get adequate sleep and improve their health, safety, academic performance, and quality of life (*5*). AAP recommended that "middle and high schools should aim for a starting time of no earlier than 8:30 a.m." (*5*). To assess state-specific distributions of public middle and high school start times and establish a pre-recommendation baseline, CDC and the U.S. Department of Education analyzed data from the 2011–12 Schools and Staffing Survey (SASS). Among an estimated 39,700 public middle, high, and combined schools* in the United States, the average start time was 8:03 a.m. Overall, only 17.7% of these public schools started school at 8:30 a.m. or later. The percentage of schools with 8:30 a.m. or later start times varied greatly by state, ranging from 0% in Hawaii, Mississippi, and Wyoming to more than three quarters of schools in Alaska (76.8%) and North Dakota (78.5%). A school system start time policy of 8:30 a.m. or later provides teenage students the opportunity to achieve the 8.5–9.5 hours of sleep recommended by AAP (*5*) and the 8–10 hours recommended by the National Sleep Foundation (*6*).

* Middle schools include any schools with no grade lower than 5 and no grade higher than 8. High schools include any school with no grade lower than 7 and at least one grade higher than 8. Combined schools include any schools with at least one grade lower than 7 and at least one grade higher than 8, or with all students in ungraded classrooms.

Every few years, the U.S. Department of Education conducts SASS, which provides data on the condition of elementary and secondary education in the United States. SASS consists of several questionnaires, including those tailored to schools, teachers, principals, school districts, and library media centers. SASS is a mail-based survey, with telephone and field follow-up, and uses a stratified probability sample design.† For the 2011–12 school year, the sample included about 10,250 traditional public schools and 750 public charter schools, with a unit response rate for public schools of 72.5%. As part of the school questionnaire in the 2011–12 school year, respondents were asked, "At what time do most of the students in

† Additional information available at http://nces.ed.gov/surveys/sass/overview.asp and http://nces.ed.gov/statprog/handbook/sass_surveydesign.asp. Questions about SASS can be directed to Chelsea Owens at chelsea.owens@ed.gov.

INSIDE

814 Alcohol-Impaired Driving Among Adults — United States, 2012
818 Prevention and Control of Influenza with Vaccines: Recommendations of the Advisory Committee on Immunization Practices, United States, 2015–16 Influenza Season
826 Vital Signs: Estimated Effects of a Coordinated Approach for Action to Reduce Antibiotic-Resistant Infections in Health Care Facilities — United States
832 Notes from the Field: Lack of Measles Transmission to Susceptible Contacts from a Health Care Worker with Probable Secondary Vaccine Failure — Maricopa County, Arizona, 2015
834 QuickStats

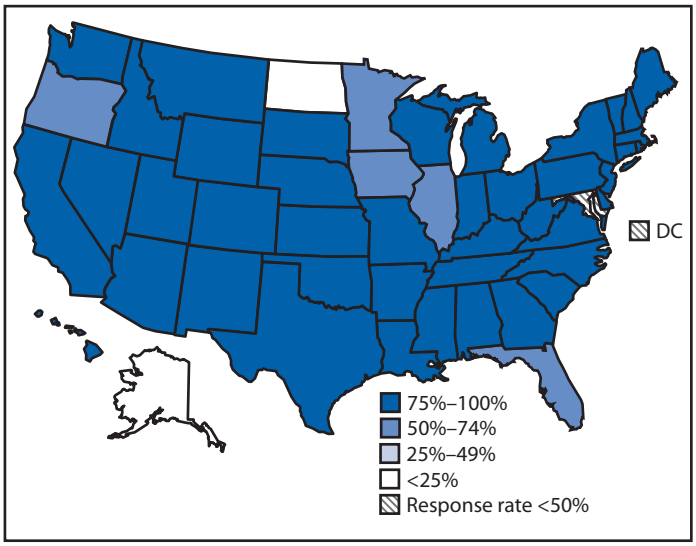
Continuing Education examination available at http://www.cdc.gov/mmwr/cme/conted_info.html#weekly.

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

this school begin the school day?" Because AAP recommends school start times of 8:30 a.m. or later for both middle schools and high schools, the analyses in this report include public middle schools, high schools, and schools with combined grades. Average start time (with standard error) and percentage distribution of start times were calculated by school level and state. Results are weighted to reflect the complex sample design and to account for nonresponse and other adjustments.

Among an estimated 39,700 U.S. public middle, high, and combined schools (with an estimated total enrollment of 26.3 million students), the average start time was 8:03 a.m. Forty-two states reported that 75%–100% of their public schools had early start times (before 8:30 a.m.) (Figure). Overall, only 17.7% of public schools (with an estimated total enrollment of 4.2 million students), started school at 8:30 a.m. or later (Table). The proportion was lowest for high schools (14.4%) and highest for combined schools (23.4%). The percentage of schools that started at 8:30 a.m. or later varied greatly by state, ranging from 0% in Hawaii, Mississippi, and Wyoming to 76.8% in Alaska and 78.5% in North Dakota. North Dakota and Alaska also reported the latest average school start times (8:31 a.m. and 8:33 a.m., respectively), whereas Louisiana reported the earliest average school start time (7:40 a.m.) and the largest percentage of schools starting before 7:30 a.m. (29.9%).

FIGURE. Percentage of public schools* with early school start times (before 8:30 a.m.), by state — Schools and Staffing Survey, United States, 2011–12 school year



Source: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, public school data file, 2011–12. Additional information available at http://nces.ed.gov/surveys/sass/overview.asp.

* Includes middle, high, and combined schools. Middle schools include any schools with no grade lower than 5 and no grade higher than 8. High schools include any school with no grade lower than 7 and at least one grade higher than 8. Combined schools include any schools with at least one grade lower than 7 and at least one grade higher than 8, or with all students in ungraded classrooms.

The *MMWR* series of publications is published by the Center for Surveillance, Epidemiology, and Laboratory Services, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2015;64:[inclusive page numbers].

Centers for Disease Control and Prevention

Thomas R. Frieden, MD, MPH, *Director*
Harold W. Jaffe, MD, MA, *Associate Director for Science*
Joanne Cono, MD, ScM, *Director, Office of Science Quality*
Chesley L. Richards, MD, MPH, *Deputy Director for Public Health Scientific Services*
Michael F. Iademarco, MD, MPH, *Director, Center for Surveillance, Epidemiology, and Laboratory Services*

***MMWR* Editorial and Production Staff (Weekly)**

Sonja A. Rasmussen, MD, MS, *Editor-in-Chief*
Charlotte K. Kent, PhD, MPH, *Executive Editor*
Jacqueline Gindler, MD, *Acting Editor*
Teresa F. Rutledge, *Managing Editor*
Douglas W. Weatherwax, *Lead Technical Writer-Editor*
Teresa M. Hood, MS, Jude C. Rutledge, *Writer-Editors*

Martha F. Boyd, *Lead Visual Information Specialist*
Maureen A. Leahy, Julia C. Martinroe,
Stephen R. Spriggs, Brian E. Wood,
Visual Information Specialists
Quang M. Doan, MBA, Phyllis H. King,
Teresa C. Moreland, Terraye M. Starr
Information Technology Specialists

***MMWR* Editorial Board**

Timothy F. Jones, MD, Nashville, TN, *Chairman*
Matthew L. Boulton, MD, MPH, Ann Arbor, MI
Virginia A. Caine, MD, Indianapolis, IN
Jonathan E. Fielding, MD, MPH, MBA, Los Angeles, CA
David W. Fleming, MD, Seattle, WA
William E. Halperin, MD, DrPH, MPH, Newark, NJ

King K. Holmes, MD, PhD, Seattle, WA
Rima F. Khabbaz, MD, Atlanta, GA
Patricia Quinlisk, MD, MPH, Des Moines, IA
Patrick L. Remington, MD, MPH, Madison, WI
William L. Roper, MD, MPH, Chapel Hill, NC
William Schaffner, MD, Nashville, TN

TABLE. Average start time and percentage distribution of start times for public middle, high, and combined schools,* by school level and state — Schools and Staffing Survey 2011–12 school year

School level and state	Estimated no. of public middle, high, and combined schools		Estimated no. of students in public middle, high, and combined schools		Average start time (a.m.)¶ Before 7:30 a.m.		Percentage distribution† of public middle, high, and combined school start times: 7:30 a.m. to 7:59 a.m.		8:00 a.m. to 8:29 a.m.		8:30 a.m. or later		8:30 a.m. or later	
	No.	(SE)	No.	(SE)	Time	(SE)§	%	(SE)	%	(SE)	%	(SE)	%	(SE)
Total	**39,700**	**(390)**	**26,284,000**	**(613,100)**	**8:03**	**(1)**	**6.7**	**(0.4)**	**31.9**	**(0.8)**	**43.7**	**(0.8)**	**17.7**	**(0.7)**
School level														
Middle	13,990	(169)	8,674,000	(135,800)	8:04	(1)	4.8	(0.7)	35.9	(1.3)	40.4	(1.1)	18.9	(1.0)
High	18,360	(434)	14,995,000	(413,600)	7:59	(1)	9.5	(0.6)	33.0	(1.1)	43.1	(1.1)	14.4	(0.9)
Combined	7,350	(571)	2,615,000	(300,600)	8:08	(3)	3.5	(0.7)	21.6	(2.2)	51.5	(2.6)	23.4	(2.7)
State														
Alabama	680	(39)	344,000	(31,100)	7:49	(2)	6.4	(2.2)††	57.8	(4.4)	34.0	(5.3)	—**	—
Alaska	—**	—	—**	—	8:33	(8)	0.0	—§§	11.6	(3.8)††	11.6	(4.8)††	76.8	(7.8)
Arizona	860	(159)	506,000	(53,100)	8:03	(3)	8.1	(2.9)††	23.3	(6.6)	47.3	(5.8)	21.3	(5.0)
Arkansas	450	(28)	292,000	(30,300)	8:01	(1)	—**	—	29	(4.7)	63.0	(4.7)	7.3	(2.0)
California	3,880	(219)	3,303,000	(146,300)	8:07	(2)	3.5	(0.9)	27.7	(3.1)	47.6	(3.3)	21.2	(2.9)
Colorado	730	(84)	527,000	(51,700)	7:54	(2)	16.9	(5.1)	31.3	(6.6)	40.9	(5.1)	10.9	(2.6)
Connecticut	380	(24)	260,000	(23,900)	7:46	(2)	13.8	(2.9)	57.4	(4.2)	24.0	(3.8)	4.8	(2.1)††
Delaware	090	(4)	63,000	(4,900)	7:42	(3)	24.0	(5.3)	51.9	(6.3)	16.6	(4.6)	7.5	(3.0)††
District of Columbia	—**	—	—**	—	—**	—	—**	—	—**	—	—**	—	—**	—
Florida	1,570	(100)	1,406,000	(111,400)	8:17	(3)	19.5	(2.5)	18.6	(2.4)	19.3	(2.9)	42.6	(3.8)
Georgia	1,030	(24)	955,000	(77,500)	8:09	(2)	—**	—	28.7	(4.3)	43.9	(4.6)	24.0	(3.4)
Hawaii	—**	—	—**	—	8:03	(3)	0.0	—§§	42.5	(17.3)††	57.5	(17.3)††	0.0	—§§
Idaho	370	(182)	157,000	(40,300)	8:13	(28)	0.0	—§§	20.9	(7.5)††	58.3	(14.5)	—**	—
Illinois	1,590	(48)	1,008,000	(145,200)	8:13	(3)	—**	—	19.7	(3.4)	48.7	(5.5)	28.4	(6.0)
Indiana	740	(27)	559,000	(43,800)	7:58	(2)	—**	—	41.8	(3.2)	45.1	(4.0)	10.2	(2.7)
Iowa	550	(35)	249,000	(31,300)	8:23	(6)	0.0	—§§	6.3	(2.0)††	66.3	(7.2)	27.4	(7.6)
Kansas	540	(20)	204,000	(20,000)	8:00	(1)	—**	—	26.5	(3.5)	71.5	(3.7)	—**	—
Kentucky	710	(32)	358,000	(33,100)	8:03	(4)	8.6	(4.2)††	24.8	(4.0)	49.0	(5.8)	17.5	(4.0)
Louisiana	630	(32)	316,000	(33,100)	7:40	(2)	29.9	(4.8)	53.1	(4.9)	12.1	(3.5)	—**	—
Maine	240	(5)	105,000	(5,500)	7:53	(3)	6.6	(1.9)	53.1	(5.1)	32.8	(4.8)	7.5	(3.6)††
Maryland	—**	—	—**	—	—**	—	—**	—	—**	—	—**	—	—**	—
Massachusetts	700	(58)	527,000	(48,600)	7:53	(4)	8.0	(3.6)††	53.3	(6.1)	27.2	(5.1)	11.5	(5.4)††
Michigan	1,540	(47)	891,000	(59,100)	7:54	(2)	9.5	(2.1)	43.6	(3.6)	39.0	(3.5)	7.9	(2.2)
Minnesota	1,100	(58)	522,000	(43,100)	8:18	(3)	0.9	(0.4)††	18.8	(2.6)	46.7	(3.7)	33.6	(3.5)
Mississippi	570	(23)	272,000	(18,600)	7:47	(2)	12.4	(3.7)††	58.3	(4.3)	29.3	(4.3)	0.0	—§§
Missouri	900	(37)	530,000	(28,700)	7:54	(1)	6.7	(1.7)	39.0	(3.9)	51.0	(3.9)	3.2	(1.4)††
Montana	220	(15)	78,000	(8,200)	8:13	(2)	0.0	—§§	5.8	(2.1)††	80.9	(6.1)	13.4	(5.5)††

See table footnotes on next page.

Discussion

Obtaining adequate sleep is important for achieving optimal health. Among adolescents, insufficient sleep has been associated with adverse risk behaviors (*2*), poor health outcomes (*1*), and poor academic performance (*3*). In view of these negative outcomes, the high prevalence of insufficient sleep among high school students is of substantial public health concern. *Healthy People 2020* includes a sleep objective for adolescents: to "increase the proportion of students in grades 9 through 12 who get sufficient sleep (defined as 8 or more hours of sleep on an average school night)."§ However, the proportion of students who get enough sleep has remained approximately 31% since 2007 (*4*), the first year that the national Youth Risk Behavior Survey included a question about sleep, meaning that more than two thirds of high school students do not get enough sleep. Multiple contributors to insufficient sleep in this population might exist. In puberty, biological rhythms commonly shift so that adolescents become sleepy later at night and need to sleep later in the morning (*7*). These biological changes are often combined with poor sleep hygiene (including irregular bedtimes and the presence of televisions, computers, or mobile phones in the bedroom) (*8*). During the school week, the chief determinant of wake times is school start time (*9*). The combination of delayed bedtimes and early school start times results in inadequate sleep for a large portion of the adolescent population.

Citing evidence of the benefits of delayed school start times for adolescents, AAP released a policy statement in 2014 that encouraged middle and high schools to modify start times to enable students to get sufficient sleep and subsequently improve their health, safety, academic performance, and quality of

§ Information on *Healthy People 2020* sleep objectives is available at http://www.healthypeople.gov/2020/topics-objectives/topic/sleep-health.

TABLE. (*Continued*) Average start time and percentage distribution of start times for public middle, high, and combined schools,* by school level and state — Schools and Staffing Survey 2011–12 school year

School level and state	Estimated no. of public middle, high, and combined schools		Estimated no. of students in public middle, high, and combined schools		Average start time (a.m.)¶ Before 7:30 a.m.		Percentage distribution† of public middle, high, and combined school start times: 7:30 a.m. to 7:59 a.m.		8:00 a.m. to 8:29 a.m.		8:30 a.m. or later		8:30 a.m. or later	
	No.	(SE)	No.	(SE)	Time	(SE)§	%	(SE)	%	(SE)	%	(SE)	%	(SE)
Nebraska	370	(26)	150,000	(19,200)	8:07	(1)	0.0	—§§	8.0	(2.5)††	88.9	(2.4)	3.0	(1.4)††
Nevada	260	(12)	276,000	(20,900)	7:51	(3)	18.0	(3.0)	30.7	(5.5)	38.2	(6.0)	13.1	(3.6)
New Hampshire	180	(18)	116,000	(7,800)	7:46	(2)	11.6	(3.2)	64.4	(5.7)	19.7	(4.4)	—**	—
New Jersey	870	(52)	698,000	(45,200)	8:00	(2)	6.7	(2.0)	37.2	(4.5)	41.2	(4.7)	14.9	(3.6)
New Mexico	310	(99)	151,000	(47,000)	8:10	(3)	1.6	(0.7)††	24.1	(5.8)	53.9	(10.2)	20.4	(5.9)
New York	2,070	(108)	1,670,000	(149,100)	7:59	(2)	7.7	(3.1)††	31.6	(2.9)	49.6	(3.4)	11.0	(2.5)
North Carolina	1,120	(35)	768,000	(88,900)	8:03	(2)	—**	—	36.6	(5.0)	45.3	(5.4)	15.2	(4.2)
North Dakota	220	(9)	67,000	(5,000)	8:31	(1)	0.0	—§§	2.8	(1.2)††	18.7	(3.2)	78.5	(3.4)
Ohio	1,640	(73)	1,061,000	(60,800)	7:52	(2)	13.1	(2.0)	45.3	(4.3)	29.3	(3.7)	12.3	(3.0)
Oklahoma	700	(27)	356,000	(29,000)	8:10	(2)	0.0	—§§	12.0	(2.8)	77.6	(3.9)	10.4	(2.8)
Oregon	480	(25)	282,000	(21,100)	8:14	(3)	—**	—	25.2	(3.8)	45.0	(4.1)	28.9	(4.2)
Pennsylvania	1,280	(145)	1,001,000	(189,700)	7:48	(2)	13.0	(3.0)	51.3	(6.6)	32.6	(7.9)	3.1	(1.3)††
Rhode Island	100	(10)	68,000	(6,200)	7:50	(4)	24.8	(6.1)	27.5	(7.9)	40.3	(9.2)	—**	—
South Carolina	500	(9)	411,000	(26,400)	8:03	(2)	—**	—	35.3	(6.5)	50.9	(6.8)	12.3	(3.7)
South Dakota	230	(11)	78,000	(5,200)	8:13	(2)	—**	—	6.6	(2.7)††	77.7	(4.2)	14.8	(4.9)††
Tennessee	760	(47)	533,000	(31,000)	7:57	(3)	13.3	(3.4)	29.4	(4.7)	40.0	(5.1)	17.2	(3.5)
Texas	3,940	(183)	2,556,000	(254,700)	8:05	(2)	3.1	(1.2)††	28.3	(3.4)	46.3	(3.5)	22.4	(2.7)
Utah	410	(22)	297,000	(45,200)	8:05	(3)	0.0	—§§	33.1	(5.3)	49.6	(5.9)	17.3	(5.9)††
Vermont	100	(2)	46,000	(2,600)	8:05	(2)	—**	—	34.1	(5.1)	48.0	(4.8)	15.1	(3.0)
Virginia	850	(17)	555,000	(37,700)	8:04	(2)	10.0	(2.6)	26.6	(4.4)	42.6	(4.4)	20.8	(3.6)
Washington	930	(35)	526,000	(42,300)	8:08	(2)	6.4	(1.9)††	24.2	(3.8)	50.2	(4.6)	19.3	(3.5)
West Virginia	300	(5)	160,000	(7,000)	7:54	(2)	11.1	(2.0)	33.9	(3.3)	47.9	(4.0)	7.1	(2.3)††
Wisconsin	860	(37)	423,000	(44,200)	7:59	(3)	2.3	(1.0)††	48.2	(5.4)	39.1	(4.3)	10.4	(4.4)††
Wyoming	130	(8)	50,000	(4,300)	7:59	(1)	0.0	—§§	41.1	(5.2)	58.9	(5.2)	0.0	—§§

Source: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS), "Public School Data File," 2011–12.
Abbreviation: SE = standard error.
* Middle schools include any schools with no grade lower than 5 and no grade higher than 8. High schools include any school with no grade lower than 7 and at least one grade higher than 8. Combined schools include any schools with at least one grade lower than 7 and at least one grade higher than 8, or with all students in ungraded classrooms.
† Detail may not sum to totals because of rounding and because some data are not shown.
§ SE of average start time is expressed in minutes.
¶ Schools with afternoon start times were not included in analysis.
** Reporting standards not met. Relative standard error ≥0.5 or the response rate <50%.
†† Interpret data with caution. 0.3 ≤ relative standard error < 0.5.
§§ Rounds to zero. SE is not applicable.

life (*5*). AAP recommended that schools start at 8:30 a.m. or later (*5*), but this was the case in only one in six U.S. public middle and high schools, with substantial variation by state. Because school start times are determined at the district or even individual school level, local stakeholders have the most influence on whether start times change in their communities.

Groups seeking to delay school start times in their district often face resistance. Common barriers to delaying school start times include concerns about increased transportation costs because of changes in bus schedules; potential for traffic congestion for students and faculty; difficulty in scheduling after-school activities, especially athletic programs; and lack of education in some communities about the importance of sleep and school start times.¶ Advocates for delayed start times might benefit from 1) becoming familiar with research about the negative impact of insufficient sleep and early start times on adolescents' health, well-being, and academic performance; 2) identification of persons who might be impacted by the decision to delay start times, including parties involved in transportation and school athletic programs, as well as students, teachers, and school staff; and 3) preparing responses to common arguments against delaying start times. Many school systems have successfully overcome barriers to delay start times.**

Among the possible public health interventions for increasing sufficient sleep among adolescents, delaying school start times has the potential for the greatest population impact by changing the environmental context for students in entire

¶ A discussion of common barriers faced by proponents of delayed school start times is available at http://sleepfoundation.org/sleep-news/eight-major-obstacles-delaying-school-start-times.

** Several case studies that describe how this was done were compiled by the National Sleep Foundation and are available at http://www.startschoollater.net/case-studies.html.

Summary

What is already known on this topic?

The American Academy of Pediatrics (AAP) has urged middle and high schools to modify school start times to enable adolescent students to get sufficient sleep and improve their health, safety, academic performance, and quality of life. AAP recommends that schools aim to start no earlier than 8:30 a.m.

What is added by this report?

During the 2011–12 school year, before publication of the new AAP recommendations, only 17.7% of public middle and high schools in the United States started school at 8:30 a.m. or later. The percentage varied greatly by state, ranging from 0% in Hawaii, Mississippi, and Wyoming to more than three quarters of schools in Alaska (76.8%) and North Dakota (78.5%).

What are the implications for public health practice?

School start time policies are established at the district and individual school levels. Educating parents and school system decision-makers about the impact of sleep deprivation on adolescent health and academic performance might lead to adoption of later start times.

school districts. However, a late school start time does not preclude the need for other interventions that have the potential to improve the sleep of adolescents. Health care providers who treat adolescents, both in and outside of school settings, should educate patients and parents about the importance of adequate sleep, as well as factors that contribute to insufficient sleep among adolescents. Parents can help their children practice good sleep hygiene (i.e., habits that help promote good sleep). A regular bedtime and rise time, including on weekends, is recommended for everyone, whether they are children, adolescents, or adults.[††] In addition, adolescents with parent-set bedtimes usually get more sleep than those whose parents do not set bedtimes (*8*). Adolescents who are exposed to more light (such as room lighting or from electronics) in the evenings are less likely to get enough sleep (*8*). Technology use (e.g., computers, video gaming, or mobile phones) might also contribute to late bedtimes (*8*) and parents might consider implementing a "media curfew" or removing these technologies from the bedroom. Finally, parents might benefit themselves and their children by setting a good example. Adolescent sleep habits tend to reflect their parents' sleep habits (*10*).

[††] Information on healthy sleep habits, often referred to as good "sleep hygiene", is available at http://sleepfoundation.org/sleep-tools-tips/healthy-sleep-tips.

[1]Division of Population Health, National Center for Chronic Disease Prevention and Health Promotion, CDC.

Corresponding author: Anne G. Wheaton, awheaton@cdc.gov, 770-488-5362.

References

1. Lowry R, Eaton DK, Foti K, McKnight-Eily L, Perry G, Galuska DA. Association of sleep duration with obesity among US high school students. J Obes 2012;2012:476914.
2. McKnight-Eily LR, Eaton DK, Lowry R, Croft JB, Presley-Cantrell L, Perry GS. Relationships between hours of sleep and health-risk behaviors in US adolescent students. Prev Med 2011;53:271–3.
3. Perez-Lloret S, Videla AJ, Richaudeau A, et al. A multi-step pathway connecting short sleep duration to daytime somnolence, reduced attention, and poor academic performance: an exploratory cross-sectional study in teenagers. J Clin Sleep Med 2013;9:469–73.
4. Basch CE, Basch CH, Ruggles KV, Rajan S. Prevalence of sleep duration on an average school night among 4 nationally representative successive samples of American high school students, 2007–2013. Prev Chronic Dis 2014;11:E216.
5. Adolescent Sleep Working Group; Committee on Adolescence; Council on School Health. School start times for adolescents. Pediatrics 2014;134:642–9.
6. Hirshkowitz M, Whiton K, Albert SM, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep Health 2015;1:40–3.
7. Crowley SJ, Acebo C, Carskadon MA. Sleep, circadian rhythms, and delayed phase in adolescence. Sleep Med 2007;8:602–12.
8. Bartel KA, Gradisar M, Williamson P. Protective and risk factors for adolescent sleep: a meta-analytic review. Sleep Med Rev 2014;21:72–85.
9. Knutson KL, Lauderdale DS. Sociodemographic and behavioral predictors of bed time and wake time among US adolescents aged 15 to 17 years. J Pediatr 2009;154:426–30, 30 e1.
10. Fuligni AJ, Tsai KM, Krull JL, Gonzales NA. Daily concordance between parent and adolescent sleep habits. J Adolesc Health 2015;56:244–50.

Alcohol-Impaired Driving Among Adults — United States, 2012

Amy Jewett, MPH[1]; Ruth A. Shults, PhD[1]; Tanima Banerjee, MS[2]; Gwen Bergen, PhD[1]

Alcohol-impaired driving crashes account for approximately one third of all crash fatalities in the United States (*1*). In 2013, 10,076 persons died in crashes in which at least one driver had a blood alcohol concentration (BAC) ≥0.08 grams per deciliter (g/dL), the legal limit for adult drivers in the United States (*2*). To estimate the prevalence, number of episodes, and annual rate of alcohol-impaired driving, CDC analyzed self-reported data from the 2012 Behavioral Risk Factor Surveillance System (BRFSS) survey. An estimated 4.2 million adults reported at least one alcohol-impaired driving episode in the preceding 30 days, resulting in an estimated 121 million episodes and a national rate of 505 episodes per 1,000 population annually. Alcohol-impaired driving rates varied by more than fourfold among states, and were highest in the Midwest U.S. Census region. Men accounted for 80% of episodes, with young men aged 21–34 years accounting for 32% of all episodes. Additionally, 85% of alcohol-impaired driving episodes were reported by persons who also reported binge drinking, and the 4% of the adult population who reported binge drinking at least four times per month accounted for 61% of all alcohol-impaired driving episodes. Effective strategies to reduce alcohol-impaired driving include publicized sobriety checkpoints (*3*), enforcement of 0.08 g/dL BAC laws (*3*), requiring alcohol ignition interlocks for everyone convicted of driving while intoxicated (*3*), and increasing alcohol taxes (*4*).

BRFSS is an ongoing, state-based, random-digit–dialed telephone survey that collects health risk data from noninstitutionalized adults aged ≥18 years (*5*). Data from the 2012 BRFSS survey were analyzed to estimate prevalence, number of episodes, and rate of alcohol-impaired driving by selected individual characteristics and rates by state and U.S. Census region. Data from all 50 states and the District of Columbia were included. In 2011, BRFSS began conducting interviews of respondents with mobile phones in addition to landline interviews (*6*). In 2012, approximately 78% of respondents completed the survey using a landline phone; response rates were 49% for landline and 35% for mobile phones (*5*), with 467,334 completed interviews. The 2012 BRFSS data were weighted using the raking method, which reduces the potential for bias (*6*). Respondents who reported consuming any alcoholic beverages within the past 30 days were then asked, "During the past 30 days, how many times have you driven when you've had perhaps too much to drink?"

Estimates of the annual number of alcohol-impaired driving episodes per respondent were calculated by multiplying the reported episodes during the preceding 30 days by 12. These numbers of episodes were summed to obtain state and national estimates of alcohol-impaired driving episodes. Annual rates of alcohol-impaired driving episodes were calculated by dividing the annual number of episodes by the respective weighted population estimate from BRFSS for 2012. For the 13 respondents who reported more than one episode daily, annualized alcohol-impaired driving episodes were truncated at 360. Rates were suppressed for five states because the number of episodes was <50 or the standard error was >30%.

Alcohol-impaired driving prevalence was stratified by sex and reported by age, race/ethnicity, education level, marital status, household income, number of binge drinking episodes, seat belt use (always wear or less than always wear) and U.S. Census region. Binge drinking was defined as women drinking four or more alcoholic beverages per occasion and men drinking five or more alcoholic beverages per occasion. Seat belt use among alcohol-impaired drivers was examined separately by type of state seat belt law. Primary enforcement seat belt laws (primary laws) permit law enforcement to stop motorists solely for being unbelted, whereas secondary laws permit ticketing unbelted motorists only if they are stopped for another reason (*7*). New Hampshire, the only state without a seatbelt law for adults, was included with the secondary law states. Differences between subgroups were analyzed using t-tests, with a p value of ≤0.05 indicating statistical significance.

In 2012, 1.8% of respondents reported at least one alcohol-impaired driving episode during the preceding 30 days. This represented 4.2 million adults who reported an estimated 121 million annual alcohol-impaired driving episodes, a rate of 505 per 1,000 population (Table 1). Among those who reported driving while impaired, 58% indicated one episode, 23% indicated two episodes, and 17% indicated 3–10 episodes in the past 30 days; 0.8% of respondents reported they drove while impaired at least daily. Men accounted for 80% of alcohol-impaired driving episodes. Young men aged 21–34 years, who represented 11% of the U.S. adult population, reported 32% of all episodes.

Persons who reported binge drinking accounted for 85% of alcohol-impaired driving episodes, and the 4% of the adult population who reported binge drinking at least four times per month accounted for 61% of all alcohol-impaired driving episodes. Persons who wore a seat belt less than always had an annual alcohol-impaired driving rate (1,321) three times higher than those who always wore a seat belt (398). Among

TABLE 1. Percentage of adults reporting alcohol-impaired driving episodes during the preceding 30 days and annual rate of episodes per 1,000 population, by sex and selected characteristics — Behavioral Risk Factor Surveillance System, United States, 2012

	Overall				Men				Women			
Characteristic	%	No. of episodes	Annual rate	(95% CI)	%	No. of episodes	Annual rate	(95% CI)	%	No. of episodes	Annual rate	(95% CI)
Total	1.8	120,840,680	505	461–550	2.8	96,137,414	828	741–914	0.8	24,703,266	201	173–229
Age group (yrs)												
18–20	1.4	6,341,797	431	294–569	2.2	4,963,761	650	427–873	—*	—	—	—
21–24	4.2	16,709,636	1,004	814–1,195	5.8	12,301,238	1,450	1,113–1,787	2.6	4,408,397	540	373–708
25–34	3.0	32,662,609	794	630–958	4.5	26,597,672	1,282	962–1,602	1.5	6,064,937	297	240–355
35–54	1.9	44,360,681	527	450–605	3.0	35,183,421	844	700–988	0.9	9,177,260	216	158–274
≥55	0.8	20,631,892	252	210–295	1.4	16,987,417	453	365–541	0.3	3,644,475	82	56–108
Race/Ethnicity												
White, non–Hispanic	1.9	81,297,896	524	472–575	3.0	63,627,635	846	747–945	0.9	17,670,261	221	184–258
Black, non–Hispanic	1.8	12,262,181	440	349–531	2.7	8,901,599	698	528–869	1.0	3,360,582	222	137–308
Hispanic	1.8	18,638,930	518	363–673	2.9	16,579,282	917	611–1,223	0.6	2,059,648	115	78–152
Other, non–Hispanic	1.3	5,865,091	398	217–580	2.1	4,597,655	626	290–962	0.5	1,267,436	172	32–311
Multiracial, non-Hispanic	1.8	1,250,064	355	246–463	2.7	966,111	567	361–772	0.9	283,953	156	74–239
Education												
Less than high school	1.2	15,863,682	446	306–586	2.0	14,421,682	786	517–1,054	0.3	1,442,000	84	46–122
High school	1.6	33,534,025	486	422–551	2.6	27,365,716	792	676–907	0.6	6,168,309	179	120–239
Some college	2.0	42,280,497	578	472–684	3.3	33,526,025	1,012	788–1,237	1.0	8,754,472	219	162–275
College	2.2	29,162,476	474	426–522	3.2	20,823,990	691	607–775	1.3	8,338,485	266	219–313
Marital status												
Married	1.2	34,523,699	289	260–318	1.9	27,665,693	467	412–521	0.6	6,858,006	114	91–137
Unmarried couple	3.2	12,386,722	1,052	697–1,408	4.7	10,903,950	1,790	1,107–2,473	1.6	1,482,771	261	177–345
Previously married	1.6	24,538,321	521	422–619	3.0	18,620,065	1,051	811–1,291	0.7	5,918,256	201	138–265
Never married	3.0	48,329,111	798	670–927	4.2	37,973,371	1,155	930–1,379	1.6	10,355,740	374	284–465
Annual household income ($)												
<20,000	1.4	19,675,457	436	345–527	2.4	15,497,797	776	581–970	0.7	4,177,660	166	112–220
20,000–34,999	1.9	23,173,002	539	440–639	3.0	18,655,935	902	707–1,097	0.8	4,517,067	203	139–267
35,000–49,999	2.1	14,735,381	501	406–596	3.0	11,177,179	747	578–917	1.2	3,558,202	246	163–329
50,000–74,999	2.1	18,848,567	592	414–770	3.2	15,351,294	943	612–1,274	0.9	3,497,274	225	110–339
≥75,000	2.3	34,301,686	584	512–656	3.3	26,883,422	853	730–977	1.2	7,418,264	272	209–336
Binge drinking												
No binge drinking	0.8	14,753,474	181	158–204	1.2	10,177,543	253	211–296	0.5	4,575,932	111	91–131
1 time per month	4.7	11,359,118	840	690–989	5.5	8,213,096	1,027	791–1,263	3.6	3,146,022	569	440–698
2–3 times per month	8.2	19,039,754	1,611	1,388–1,834	9.7	13,917,849	1,832	1,566–2,097	5.5	5,121,905	1,213	812–1,614
≥4 times per month	14.8	73,285,148	5,637	4,875–6,398	16.2	61,905,024	6,520	5,519–7,522	11.0	11,380,124	3,244	2,453–4,035
Seatbelt use												
Less than always	4.0	42,356,829	1,321	1,101–1,541	5.3	36,527,500	1,843	1,497–2,190	2.0	5,829,329	477	344–609
Always	1.5	81,376,707	398	357–439	2.4	62,180,982	656	574–738	0.8	19,195,724	177	148–205

Abbreviation: CI = confidence interval.
* Sample size was <50 or relative standard error was >0.30.

alcohol-impaired drivers, those living in states with a secondary seat belt law were less likely to always wear their seat belt (55%) compared with those in states with a primary law (74%).

Annual alcohol-impaired driving episode rates varied more than fourfold among states, from 217 (Utah) to 995 (Hawaii) per 1,000 population (Table 2, Figure). The Midwest U.S. Census region had the highest annual alcohol-impaired driving rate at 573 per 1,000 population.

Discussion

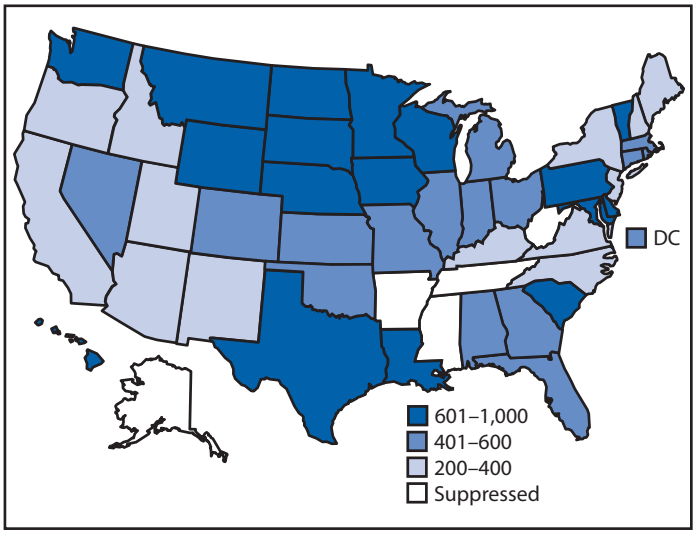
During 2012, an estimated 4.2 million U.S. adults reported driving while impaired by alcohol at least once in the preceding 30 days, resulting in an estimated 121 million alcohol-impaired driving episodes annually, and a national rate of 505 episodes per 1,000 population. Alcohol-impaired driving rates varied more than fourfold among states. Because BRFSS made changes in the survey weighting methodology and added a mobile telephone sampling frame since the alcohol-impaired driving question was last asked, direct comparisons of the 2012 results with those from earlier years were not possible. Nonetheless, the estimated number of alcohol-impaired driving episodes reported by U.S. adults in 2012 fell within the range of the 112 million to 161 million annual episodes reported from 1993 to 2010 (*8*). Also, young men aged 21–34 years

TABLE 2. Annual rate of self-reported alcohol-impaired driving episodes per 1,000 population, among adults, by U.S. Census region and state — Behavioral Risk Factor Surveillance System, United States, 2012

U.S. Census region	State	Rate	(95% CI)
National		**505**	**(461–550)**
Northeast		**481**	**(389–572)**
	Vermont	881	(309–1,452)
	Pennsylvania	701	(409–992)
	Connecticut	558	(400–717)
	Rhode Island	522	(363–680)
	Massachusetts	510	(390–630)
	New York	372	(209–536)
	New Jersey	360*	(262–458)
	Maine	324	(172–476)
	New Hampshire	313*	(203–423)
South		**525**	**(433–616)**
	Louisiana	811	(463–1,159)
	Delaware	729	(429–1,028)
	Texas	703	(348–1,058)
	South Carolina	663	(346–980)
	Alabama	539	(241–837)
	Florida	539	(346–733)
	Maryland	527	(364–690)
	Georgia	491	(230–751)
	Oklahoma	467	(250–685)
	District of Columbia	409	(152–665)
	North Carolina	389	(253–525)
	Kentucky	388	(251–525)
	Virginia	308*	(206–409)
	Arkansas	—†	—
	Mississippi	—	—
	Tennessee	—	—
	West Virginia	—	—
West		**422**	**(351–493)**
	Hawaii	995§	(641–1,349)
	Montana	885§	(655–1,116)
	Wyoming	807	(342–1,272)
	Washington	706	(265–1,147)
	Nevada	489	(292–686)
	Colorado	477	(305–650)
	California	375	(273–477)
	Idaho	362	(122–602)
	Arizona	300*	(192–408)
	Oregon	285*	(168–402)
	New Mexico	273*	(180–367)
	Utah	217*	(98–337)
	Alaska	—	—
Midwest		**573**	**(498–649)**
	Nebraska	955§	(689–1,221)
	North Dakota	855	(473–1,238)
	Wisconsin	828	(536–1,121)
	South Dakota	733	(519–946)
	Iowa	715	(547–882)
	Minnesota	646	(457–835)
	Missouri	569	(294–843)
	Ohio	566	(415–716)
	Michigan	497	(326–667)
	Kansas	482	(335–629)
	Illinois	475	(223–727)
	Indiana	432	(224–639)

Abbreviation: CI = confidence interval.
* Significantly lower than the national rate.
† Sample size was <50 or relative standard error was >0.30.
§ Significantly higher than the national rate.

FIGURE. Annual rate* of self-reported alcohol-impaired driving episodes per 1,000 population, among adults — Behavioral Risk Factor Surveillance System, United States, 2012



Abbreviation: DC = District of Columbia.
* Rates were suppressed if sample size was <50 or relative standard error was >30%.

and persons who binge drink have consistently reported the highest rates of alcohol-impaired driving. Likewise, persons living in the Midwest have consistently reported higher alcohol-impaired driving rates than those living in other regions.

Although reasons for the variation in alcohol-impaired driving across the United States are not fully understood, individual-level and state-level factors likely contribute. For example, in 2013, the estimated proportion of adults who consumed alcohol varied from 31% in Utah to 65% in Wisconsin (*9*). Additionally, effective prevention strategies have not been adopted by all states; for example, as of February 2015, 12 states prohibited the use of publicized sobriety checkpoints (*10*).

Seat belts are about 50% effective in preventing driver fatalities in crashes (*1*), and seat belt use is higher in states with a primary seat belt law compared with use in states with a secondary law (*7*). In this report, persons who did not always wear a seat belt had alcohol-impaired driving rates three times higher than those who were always belted. In addition, consistent seat belt use was especially low among alcohol-impaired drivers living in states with a secondary seat belt law. Taken together, these findings suggest that fatalities among alcohol-impaired drivers could be substantially reduced if every state had a primary seat belt law.

The findings in this report are subject to at least four limitations. First, self-reported alcohol-impaired driving as defined by the BRFSS survey cannot be equated to a specific BAC; however, 85% of episodes were reported by persons who also reported binge drinking. Second, because alcohol-impaired

Summary

What is already known on this topic?

Alcohol-impaired driving crashes account for nearly one third of all motor vehicle crash fatalities.

What is added by this report?

In 2012, an estimated 4.2 million U.S. adults reported at least one episode of alcohol-impaired driving during the preceding 30 days, equating to an estimated 121 million annual alcohol-impaired driving episodes.

What are the implications for public health practice?

To reduce alcohol-impaired driving, states and communities could consider increasing the use of effective interventions such as publicized sobriety checkpoints, strictly enforcing 0.08 g/dL blood alcohol content laws and minimum legal drinking age laws, requiring ignition interlocks for all persons convicted of alcohol-impaired driving, and increasing alcohol taxes. To reduce alcohol-impaired driving fatalities, states and communities also might consider enacting primary enforcement seat belt laws.

driving carries a stigma, these self-reported estimates might be underestimated because of social desirability bias. Third, BRFSS survey respondents were aged ≥18 years; therefore, alcohol-impaired driving episodes among younger drivers were not included. Finally, the median response rate for the 2012 BRFSS survey was only 45% (*5*), which increased the risk for response bias.

Alcohol-impaired driving crashes have accounted for about one third of all U.S. crash fatalities in the past two decades (*1,2*). To reduce alcohol-impaired driving, states and communities could consider effective interventions, such as expanding the use of publicized sobriety checkpoints (*10*); enforcing 0.08 g/dL BAC laws and minimum legal drinking age laws (*3*); requiring ignition interlocks (i.e., breath-test devices connected to a vehicle's ignition that require a driver to exhale into the device, and that prevent the engine from being started if the analyzed result exceeds a preprogrammed level) for all persons convicted of alcohol-impaired driving (*3*); and increasing alcohol taxes (*4*). Additionally, all states might consider enacting primary seat belt laws that cover all passengers to help reduce fatalities in alcohol-impaired driving crashes (*7*).

Acknowledgment

Gina Perleoni, Geospatial Analysis, Research, and Analysis Program, CDC.

[1]Division of Unintentional Injury Prevention, CDC; [2]University of Michigan Injury Center, Ann Arbor, Michigan.

(Corresponding author: Amy Jewett, acjewett@cdc.gov, 770-488-3470).

References

1. National Highway Traffic Safety Administration. Traffic safety facts 2012: a compilation of motor vehicle crash data from the Fatality Analysis Reporting System and the General Estimates System. Washington, DC: US Department of Transportation, National Highway Traffic Safety Administration; 2014. Available at http://www-nrd.nhtsa.dot.gov/Pubs/812032.pdf.
2. National Highway Traffic Safety Administration. Traffic safety facts 2013: alcohol-impaired driving. Washington, DC: US Department of Transportation, National Highway Traffic Safety Administration; 2014. Available at http://www-nrd.nhtsa.dot.gov/Pubs/812102.pdf.
3. The Guide to Community Preventive Services. Motor vehicle-related injury prevention: reducing alcohol-impaired driving. Available at http://www.thecommunityguide.org/mvoi/AID/index.html.
4. The Guide to Community Preventive Services. Preventing excessive alcohol consumption: increasing alcohol taxes. Available at http://www.thecommunityguide.org/alcohol/increasingtaxes.html.
5. CDC. Behavioral Risk Factor Surveillance System. Atlanta, GA: US Department of Health and Human Services, CDC. Available at http://www.cdc.gov/brfss/.
6. CDC. Methodologic changes in the Behavioral Risk Factor Surveillance System in 2011 and potential effects on prevalence estimates. MMWR Morb Mortal Wkly Rep 2012;61:410–3.
7. Highway Loss Data Institute, Insurance Institute for Highway Safety. Safety belts. Arlington, VA: Insurance Institute for Highway Safety, Highway Loss Data Institute; 2015. Available at http://www.iihs.org/iihs/topics/t/safety-belts/topicoverview.
8. CDC. Vital signs: alcohol-impaired driving among adults—United States, 2010. MMWR Morb Mortal Wkly Rep 2011;60:1351–6.
9. CDC. Behavioral Risk Factor Surveillance System. Prevalence and trends data: alcohol consumption 2013. Atlanta, GA: US Department of Health and Human Services, CDC. Available at http://www.cdc.gov/brfss/brfssprevalence/index.html.
10. Governors Highway Safety Association. Sobriety checkpoint laws. Washington, DC: Governors Highway Safety Association; 2015. Available at http://www.ghsa.org/html/stateinfo/laws/checkpoint_laws.html.

Prevention and Control of Influenza with Vaccines: Recommendations of the Advisory Committee on Immunization Practices, United States, 2015–16 Influenza Season

Lisa A. Grohskopf, MD[1]; Leslie Z. Sokolow, MSc, MPH[1,2]; Sonja J. Olsen, PhD[1]; Joseph S. Bresee, MD[1]; Karen R. Broder, MD[3]; Ruth A. Karron, MD[4]

This report updates the 2014 recommendations of the Advisory Committee on Immunization Practices (ACIP) regarding the use of seasonal influenza vaccines (*1*). Updated information for the 2015–16 season includes 1) antigenic composition of U.S. seasonal influenza vaccines; 2) information on influenza vaccine products expected to be available for the 2015–16 season; 3) an updated algorithm for determining the appropriate number of doses for children aged 6 months through 8 years; and 4) recommendations for the use of live attenuated influenza vaccine (LAIV) and inactivated influenza vaccine (IIV) when either is available, including removal of the 2014–15 preferential recommendation for LAIV for healthy children aged 2 through 8 years. Information regarding topics related to influenza vaccination that are not addressed in this report is available in the 2013 ACIP seasonal influenza recommendations (*2*).

Recommendations for routine use of vaccines in children, adolescents, and adults are developed by the Advisory Committee on Immunization Practices (ACIP). ACIP is chartered as a federal advisory committee to provide expert external advice and guidance to the Director of the Centers for Disease Control and Prevention (CDC) on use of vaccines and related agents for the control of vaccine-preventable diseases in the civilian population of the United States. Recommendations for routine use of vaccines in children and adolescents are harmonized to the greatest extent possible with recommendations made by the American Academy of Pediatrics (AAP), the American Academy of Family Physicians (AAFP), and the American College of Obstetricians and Gynecologists (ACOG). Recommendations for routine use of vaccines in adults are harmonized with recommendations of AAFP, ACOG, and the American College of Physicians (ACP). ACIP recommendations adopted by the CDC Director become agency guidelines on the date published in the Morbidity and Mortality Weekly Report (MMWR). *Additional information regarding ACIP is available at http://www.cdc.gov/vaccines/acip.*

Information in this report reflects discussions during public meetings of ACIP held on February 26 and June 24, 2015. Subsequent modifications were made during CDC clearance review to update information and clarify wording. Meeting minutes, information on ACIP membership, and information on conflicts of interest are available at http://www.cdc.gov/vaccines/acip/committee/members.html. Any updates will be posted at http://www.cdc.gov/flu.

Groups Recommended for Vaccination and Timing of Vaccination

Routine annual influenza vaccination is recommended for all persons aged ≥6 months who do not have contraindications. Optimally, vaccination should occur before onset of influenza activity in the community. Health care providers should offer vaccination by October, if possible. Vaccination should continue to be offered as long as influenza viruses are circulating. Children aged 6 months through 8 years who require 2 doses (see "Vaccine Dose Considerations for Children Aged 6 Months through 8 Years") should receive their first dose as soon as possible after vaccine becomes available, and the second dose ≥4 weeks later. To avoid missed opportunities for vaccination, providers should offer vaccination to unvaccinated persons aged ≥6 months during routine health care visits and hospitalizations when vaccine is available.

Antibody levels induced by vaccine decline after vaccination (*3*–*5*). Although a 2008 literature review found no clear evidence of more rapid decline among older adults (*6*), a 2010 study noted a statistically significant decline in antibody titers 6 months after vaccination among persons aged ≥65 years (*5*). A case-control study conducted in Navarre, Spain, during the 2011–12 influenza season revealed a decline in vaccine effectiveness, primarily affecting persons aged ≥65 years (*7*). While delaying vaccination might permit greater immunity later in the season, deferral might result in missed opportunities to vaccinate, as well as difficulties in vaccinating a population within a more constrained time period. Vaccination programs should balance maximizing the likelihood of persistence of vaccine-induced protection through the season with avoiding missed opportunities to vaccinate or vaccinating after influenza virus circulation begins.

Influenza Vaccine Composition for the 2015–16 Season

For 2015–16, U.S.-licensed trivalent influenza vaccines will contain hemagglutinin (HA) derived from an A/California/7/2009 (H1N1)-like virus, an A/Switzerland/9715293/2013 (H3N2)-like virus, and a B/Phuket/3073/2013-like (Yamagata lineage) virus. This represents changes in the influenza A (H3N2) virus and the influenza B virus as compared with the 2014–15 season. Quadrivalent influenza vaccines will contain these vaccine viruses, and a B/Brisbane/60/2008-like (Victoria lineage) virus, which is the same Victoria lineage virus recommended for quadrivalent formulations in 2013–14 and 2014–15 (*8*).

Available Vaccine Products and Indications

Various influenza vaccine products are anticipated to be available during the 2015–16 season (Table). These recommendations apply to all licensed influenza vaccines used within Food and Drug Administration (FDA)-licensed indications. Differences between ACIP recommendations and labeled indications are noted in the Table. For persons for whom more than one type of vaccine is appropriate and available, ACIP does not express a preference for use of any particular product over another.

New and updated influenza vaccine product approvals include the following:

1. In August 2014, FDA approved Afluria (inactivated influenza vaccine, bioCSL, Inc., King of Prussia, Pennsylvania) for intramuscular administration via the Stratis needle-free jet injector (PharmaJet, Inc., Golden, Colorado), for persons aged 18 through 64 years (*9*). Adults aged 18 through 64 years may receive Afluria either by the Stratis injector or with a sterile needle and syringe. All other inactivated influenza vaccines are approved for administration by sterile needle and syringe only. The Stratis injector is a reusable spring-powered device which injects the vaccine through a single-use sterile needle-free syringe into the deltoid muscle. In a prelicensure study of 1,250 adults aged 18 through 64 years (*10*), local injection site symptoms were reported more frequently by persons who received Afluria via the Stratis Injector than those who were vaccinated with a sterile needle and syringe; most resolved within 3 days. Those who received Afluria via the Stratis injector had antibody levels against influenza virus that were noninferior to those who received Afluria by sterile needle and syringe. Data comparing rates of influenza illness in persons vaccinated with the Stratis injector versus needle and syringe are not available.
2. In October 2014, FDA approved an expanded age indication for the use of Flublok (Recombinant Influenza Vaccine, Trivalent [RIV3], Protein Sciences, Meriden, Connecticut), which was previously approved for persons aged 18 through 49 years. Flublok is now indicated for persons aged ≥18 years (*11*). Approval for persons aged ≥50 years is based upon studies of immunogenicity and safety of the vaccine in three randomized trials (*12–14*); data demonstrating a decrease in influenza disease in persons aged ≥50 years after vaccination with Flublok are not available.
3. In December 2014, FDA approved Fluzone Intradermal Quadrivalent (Sanofi Pasteur, Inc., Swiftwater, Pennsylvania), for persons aged 18 through 64 years (*15*). It is anticipated that this formulation will replace the previously available trivalent Fluzone Intradermal for the 2015–16 influenza season. In a randomized study of 3,355 adults aged 18 through 64 years comparing safety and immunogenicity of Fluzone Intradermal Quadrivalent with two different trivalent intradermal formulations of Fluzone (each one containing one of the two influenza B viruses contained in the quadrivalent vaccine), the quadrivalent formulation was immunogenically noninferior to the trivalent formulations for the influenza A and matched B viruses, immunogenically superior for the unmatched B viruses, and had a similar adverse event profile (*16*). Efficacy data for Fluzone Intradermal Quadrivalent are not available.

Vaccine Dose Considerations for Children Aged 6 Months Through 8 Years

Children aged 6 months through 8 years require 2 doses of influenza vaccine (administered ≥4 weeks apart) during their first season of vaccination to optimize response (*17–19*). Since the emergence of influenza A(H1N1)pdm09 (the 2009 H1N1 pandemic virus), recommendations for determining the number of doses needed have specified previous receipt of vaccine containing influenza A(H1N1)pdm09. In light of the continuing circulation of influenza A(H1N1)pdm09 as the predominant influenza A(H1N1) virus since 2009, and the inclusion of an A/California/7/2009(H1N1)-like virus in U.S. seasonal influenza vaccines since the 2010–2011 season, separate consideration of receipt of vaccine doses containing this virus is no longer recommended.

Several studies have suggested that for viruses which are the same in both doses of vaccine, longer intervals between the 2 doses do not compromise immune response (*20–22*). In a study conducted across two seasons during which the influenza A(H1N1) vaccine virus did not change but the B virus did change, children aged 10 through 24 months who

TABLE. Influenza vaccines — United States, 2015–16 influenza season*

Trade name	Manufacturer	Presentation	Mercury (from thimerosal) μg/0.5 mL	Ovalbumin μg/0.5 mL	Age indications	Latex	Route
Inactivated influenza vaccine, quadrivalent (IIV4), standard dose							
Contraindications: Severe allergic reaction to any vaccine component, including egg protein, or after previous dose of any influenza vaccine.*							
Precautions: Moderate to severe acute illness with or without fever; history of Guillain-Barré syndrome within 6 weeks of receipt of influenza vaccine.*							
Fluarix Quadrivalent	GlaxoSmithKline	0.5 mL single-dose prefilled syringe	—	≤0.05	≥3 yrs	No	IM†
FluLaval Quadrivalent	ID Biomedical Corp. of Quebec (distributed by GlaxoSmithKline)	5.0 mL multi-dose vial	<25	≤0.3	≥3 yrs	No	IM†
Fluzone Quadrivalent	Sanofi Pasteur	0.25 mL single-dose prefilled syringe	—	§	6 through 35 mos	No	IM†
		0.5 mL single-dose prefilled syringe	—	§	≥36 mos	No	IM†
		0.5 mL single-dose vial	—	§	≥36 mos	No	IM†
		5.0 mL multi-dose vial	25	§	≥6 mos	No	IM†
Fluzone Intradermal¶ Quadrivalent	Sanofi Pasteur	0.1 mL single-dose prefilled microinjection system	—	§	18 through 64 yrs	No	ID**
Inactivated influenza vaccine, trivalent (IIV3), standard dose							
Contraindications: Severe allergic reaction to any vaccine component, including egg protein, or after previous dose of any influenza vaccine.*							
Precautions: Moderate to severe acute illness with or without fever; history of Guillain-Barré syndrome within 6 weeks of receipt of influenza vaccine.*							
Afluria	bioCSL	0.5 mL single-dose prefilled syringe	—	<1	≥9 yrs††	No	IM†
		5.0 mL multi-dose vial	24.5	<1	≥9 yrs†† via needle;18 through 64 yrs via jet injector	No	IM†
Fluvirin	Novartis Vaccines and Diagnostics	0.5 mL single-dose prefilled syringe	≤1	≤1	≥4 yrs	Yes§§	IM†
		5.0 mL multi-dose vial	25	≤1	≥4 yrs	No	IM†
Fluzone	Sanofi Pasteur	5.0 mL multi-dose vial	25	§	≥6 mos	No	IM†
Inactivated influenza vaccine, cell-culture-based (ccIIV3), standard dose							
Contraindications: Severe allergic reaction to any vaccine component, including egg protein, or after previous dose of any influenza vaccine.*							
Precautions: Moderate to severe acute illness with or without fever; history of Guillain-Barré syndrome within 6 weeks of receipt of influenza vaccine.*							
Flucelvax	Novartis Vaccines and Diagnostics	0.5 mL single-dose prefilled syringe	—	¶¶	≥18 yrs	Yes§§	IM†
Inactivated influenza vaccine, trivalent (IIV3), high dose							
Contraindications: Severe allergic reaction to any vaccine component, including egg protein, or after previous dose of any influenza vaccine.*							
Precautions: Moderate to severe acute illness with or without fever; history of Guillain-Barré syndrome within 6 weeks of receipt of influenza vaccine.*							
Fluzone High-Dose***	Sanofi Pasteur	0.5 mL single-dose prefilled syringe	—	§	≥65 yrs	No	IM†
Recombinant influenza vaccine, trivalent (RIV3), standard dose							
Contraindications: Severe allergic reaction to any vaccine component.*							
Precautions: Moderate to severe acute illness with or without fever; history of Guillain-Barré syndrome within 6 weeks of receipt of influenza vaccine.*							
Flublok	Protein Sciences	0.5 mL single-dose vial	—	0	≥18 yrs	No	IM†
Live attenuated influenza vaccine, quadrivalent (LAIV4)							
Contraindications: Severe allergic reaction to any vaccine component, including egg protein, or after previous dose of any influenza vaccine. Concomitant use of aspirin or aspirin-containing medications in children and adolescents.*							
In addition, ACIP recommends LAIV4 not be used for pregnant women, immunosuppressed persons, persons with egg allergy, and children aged 2 through 4 years who have asthma or who have had a wheezing episode noted in the medical record within the past 12 months, or for whom parents report that a health care provider stated that they had wheezing or asthma within the last 12 months.							
LAIV4 should not be administered to persons who have taken influenza antiviral medications within the previous 48 hours.							
Persons who care for severely immunosuppressed persons who require a protective environment should not receive LAIV4, or should avoid contact with such persons for 7 days after receipt.							
Precautions: Moderate to severe acute illness with or without fever; history of Guillain-Barré syndrome within 6 weeks of receipt of influenza vaccine; asthma in persons aged 5 years and older; medical conditions which might predispose to higher risk for complications attributable to influenza.*							
FluMist Quadrivalent†††	MedImmune	0.2 mL single-dose prefilled intranasal sprayer	—	<0.24 (per 0.2 mL)	2 through 49 yrs	No	IN

See table footnotes on page next page.

TABLE. (*Continued*) Influenza vaccines — United States, 2015–16 influenza season*

Abbreviations: ACIP = Advisory Committee on Immunization Practices; ID = intradermal; IM = intramuscular; IN = intranasal.

* Immunization providers should check Food and Drug Administration-approved prescribing information for 2015–16 influenza vaccines for the most complete and updated information, including (but not limited to) indications, contraindications, warnings, and precautions. Package inserts for U.S.-licensed vaccines are available at www.fda.gov/BiologicsBloodVaccines/Vaccines/ApprovedProducts/ucm093833.htm.

† For adults and older children, the recommended site for intramuscular influenza vaccination is the deltoid muscle. The preferred site for infants and young children is the anterolateral aspect of the thigh. Specific guidance regarding site and needle length for intramuscular administration may be found in the ACIP General Recommendations on Immunization, available at www.cdc.gov/mmwr/preview/mmwrhtml/rr6002a1.htm.

§ Available upon request from Sanofi Pasteur (1–800–822–2463 or MIS.Emails@sanofipasteur.com).

¶ Quadrivalent inactivated influenza vaccine, intradermal: a 0.1-mL dose contains 9 μg of each vaccine antigen (36 μg total).

** The preferred injection site is over the deltoid muscle. Fluzone Intradermal Quadrivalent is administered using the delivery system included with the vaccine.

†† Age indication per package insert is ≥5 years; however, ACIP recommends Afluria not be used in children aged 6 months through 8 years because of increased risk of febrile reactions noted in this age group with bioCSL's 2010 Southern Hemisphere IIV3. If no other age-appropriate, licensed inactivated seasonal influenza vaccine is available for a child aged 5 through 8 years who has a medical condition that increases the child's risk for influenza complications, Afluria can be used; however, providers should discuss with the parents or caregivers the benefits and risks of influenza vaccination with Afluria before administering this vaccine. Afluria may be used in persons aged ≥9 years.

§§ Syringe tip cap may contain natural rubber latex.

¶¶ Information not included in package insert. Estimated to contain <50 femtograms (5×10^{-8} μg) of total egg protein (of which ovalbumin is a fraction) per 0.5 mL dose of Flucelvax.

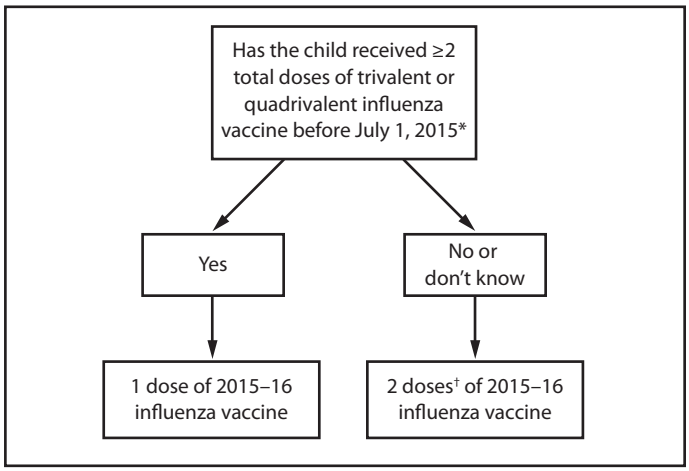
*** Trivalent inactivated influenza vaccine, high-dose: a 0.5-mL dose contains 60 μg of each vaccine antigen (180 μg total).

††† FluMist is shipped refrigerated and stored in the refrigerator at 35°F–46°F (2°C–8°C) after arrival in the vaccination clinic. The dose is 0.2 mL divided equally between each nostril. Health care providers should consult the medical record, when available, to identify children aged 2 through 4 years with asthma or recurrent wheezing that might indicate asthma. In addition, to identify children who might be at greater risk for asthma and possibly at increased risk for wheezing after receiving LAIV, parents or caregivers of children aged 2 through 4 years should be asked: "In the past 12 months, has a health care provider ever told you that your child had wheezing or asthma?" Children whose parents or caregivers answer "yes" to this question and children who have asthma or who had a wheezing episode noted in the medical record within the past 12 months should not receive FluMist.

received 1 dose of IIV during the fall of each season had similar immune responses to the unchanged A(H1N1) virus antigen and to the drifted A(H3N2) virus antigen, compared with children aged 6 through 24 months who received 2 doses of the same IIV during the latter season. However, the first group had significantly lower antibody responses to the B antigen (*20*). Since the 2010–11 season, guidance for determining the appropriate number of doses has taken strain changes into account. Because of the change in vaccine composition for 2015–16, children aged 6 months through 8 years will need to have received ≥2 doses of influenza vaccine previously to require only 1 dose for the 2015–16 season.

For 2015–16, ACIP recommends that children aged 6 months through 8 years who have previously received ≥2 total doses of trivalent or quadrivalent influenza vaccine before July 1, 2015, require only 1 dose for 2015–16. The two previous doses need not have been given during the same season or consecutive seasons. Children in this age group who have not previously received a total of ≥2 doses of trivalent or quadrivalent influenza vaccine before July 1, 2015 require 2 doses for 2015–16. The interval between the 2 doses should be at least 4 weeks (Figure 1).

FIGURE 1. Influenza vaccine dosing algorithm for children aged 6 months through 8 years — Advisory Committee on Immunization Practices, United States, 2015–16 influenza season



* The two doses need not have been received during the same season or consecutive seasons.

† Doses should be administered ≥4 weeks apart.

Considerations for the Use of Live Attenuated Influenza Vaccine and Inactivated Influenza Vaccine When Either is Available

Both LAIV and IIV have been demonstrated to be effective in children and adults. Among adults, most comparative studies have demonstrated that LAIV and IIV were of similar efficacy or that IIV was more efficacious (*23*). Several studies conducted before the 2009 H1N1 pandemic demonstrated superior efficacy of LAIV in children (*24–26*). A randomized controlled trial conducted during the 2004–05 season among 7,852 children aged 6 through 59 months demonstrated a 55% reduction in culture-confirmed influenza among children who received trivalent LAIV (LAIV3) compared with those who received trivalent IIV (IIV3). LAIV3 efficacy was higher than that of IIV3 against both antigenically drifted and well-matched influenza viruses (*24*). In a comparative study conducted during the 2002–03 season, LAIV3 provided 53%

greater relative efficacy compared with IIV3 in children aged 6 through 71 months who had previously experienced recurrent respiratory tract infections (*25*).

In June 2014, following review of evidence on the relative efficacy of LAIV compared with IIV for healthy children, ACIP recommended that when immediately available, LAIV should be used for healthy children aged 2 through 8 years who have no contraindications or precautions. However, data from subsequent observational studies of LAIV and IIV vaccine effectiveness indicated that LAIV did not perform as well as expected based upon the observations in earlier randomized trials (*27*,*28*). Analysis of data from three observational studies of LAIV4 vaccine effectiveness for the 2013–14 season (the first season in which LAIV4 was available) revealed poor effectiveness of LAIV4 against influenza A(H1N1)pdm09 among children aged 2 through 17 years (*27*). During this season, H1N1pdm09 virus predominated for the first time since the 2009 pandemic. The reasons for the lack of effectiveness of LAIV4 against influenza A(H1N1)pdm09 are still under investigation. Moreover, although one large randomized trial observed superior relative efficacy of LAIV3 compared with IIV3 against antigenically drifted H3N2 influenza viruses during the 2004–05 season (*24*), interim analysis of observational data from the U.S. Influenza Vaccine Effectiveness (U.S. Flu VE) Network for the early 2014–15 season (in which antigenically drifted H3N2 viruses were predominant) indicated that neither LAIV4 nor IIV provided significant protection in children aged 2 through 17 years; LAIV did not offer greater protection than IIV for these viruses (*28*).

In the absence of data demonstrating consistent greater relative effectiveness of the current quadrivalent formulation of LAIV, preference for LAIV over IIV is no longer recommended. ACIP will continue to review the effectiveness of influenza vaccines in future seasons and update these recommendations if warranted.

For children and adults with chronic medical conditions conferring a higher risk for influenza complications, data on the relative safety and efficacy of LAIV and IIV are limited. In a study comparing LAIV3 and IIV3 among children aged 6 through 17 years with asthma conducted during the 2002–03 season, LAIV conferred 32% increased protection relative to IIV in preventing culture-confirmed influenza; no significant difference in asthma exacerbation events was noted (*26*). Available data are insufficient to determine the level of severity of asthma for which administration of LAIV would be appropriate.

For 2015–16, ACIP recommends the following:

1. All persons aged ≥6 months should receive influenza vaccine annually. Influenza vaccination should not be delayed to procure a specific vaccine preparation if an appropriate one is already available.
2. For healthy children aged 2 through 8 years who have no contraindications or precautions, either LAIV or IIV is an appropriate option. No preference is expressed for LAIV or IIV for any person aged 2 through 49 years for whom either vaccine is appropriate. An age-appropriate formulation of vaccine should be used.
3. LAIV should not be used in the following populations:
   - Persons aged <2 years or >49 years;
   - Persons with contraindications listed in the package insert:
     - Children aged 2 through 17 years who are receiving aspirin or aspirin-containing products;
     - Persons who have experienced severe allergic reactions to the vaccine or any of its components, or to a previous dose of any influenza vaccine;
   - Pregnant women;
   - Immunocompromised persons (see also "Vaccine Selection and Timing of Vaccination for Immunocompromised Persons");
   - Persons with a history of egg allergy;
   - Children aged 2 through 4 years who have asthma or who have had a wheezing episode noted in the medical record within the past 12 months, or for whom parents report that a health care provider stated that they had wheezing or asthma within the last 12 months (Table, footnote). For persons aged ≥5 years with asthma, recommendations are described in item 4 of this list;
   - Persons who have taken influenza antiviral medications within the previous 48 hours.
4. In addition to the groups for whom LAIV is not recommended above, the "Warnings and Precautions" section of the LAIV package insert indicates that persons of any age with asthma might be at increased risk for wheezing after administration of LAIV (*29*). The package insert also notes that the safety of LAIV in persons with other underlying medical conditions that might predispose them to complications after wild-type influenza virus infection (e.g., chronic pulmonary, cardiovascular [except isolated hypertension], renal, hepatic, neurologic, hematologic, or metabolic disorders [including diabetes mellitus]) (*2*), has not been established. These conditions, in addition to asthma in persons aged ≥5 years, should be considered precautions for the use of LAIV.
5. Persons who care for severely immunosuppressed persons who require a protective environment should not receive LAIV, or should avoid contact with such persons for 7 days

after receipt, given the theoretical risk for transmission of the live attenuated vaccine virus to close contacts.

Influenza Vaccination of Persons With a History of Egg Allergy

Severe allergic and anaphylactic reactions can occur in response to various influenza vaccine components, but such reactions are rare. With the exceptions of recombinant influenza vaccine (RIV3, Flublok) and cell-culture based inactivated influenza vaccine (ccIIV3, Flucelvax, Novartis, Cambridge, Massachusetts), currently available influenza vaccines are prepared by propagation of virus in embryonated eggs. A 2012 review of published data, including 4,172 egg-allergic patients (513 reporting a history of severe allergic reaction) noted no occurrences of anaphylaxis following administration of IIV3, though some milder reactions did occur (*30*). This suggests that severe allergic reactions to egg-based influenza vaccines are unlikely. On this basis, some guidance recommends that no additional measures are needed when administering influenza vaccine to egg-allergic persons (*31*). However, occasional cases of anaphylaxis in egg-allergic persons have been reported to the Vaccine Adverse Event Reporting System (VAERS) after administration of influenza vaccine (*32*,*33*). IIVs containing as much as 0.7 μg/0.5 mL have reportedly been tolerated (*34*,*35*); however, a threshold below which no reactions would be expected is not known (*34*). Among IIVs for which ovalbumin content was disclosed during the 2011–12 through 2014–15 seasons, reported maximum amounts were ≤1 μg/0.5 mL dose; however, not all manufacturers disclose this information in the package inserts. Ovalbumin is not directly measured for Flucelvax, but it is estimated by calculation from the initial content in the reference virus strains to contain less than 5×10^{-8} μg/0.5 mL dose of total egg protein, of which ovalbumin is a fraction (Novartis, unpublished data, 2013). Flublok is considered egg-free. However, neither Flucelvax nor Flublok is licensed for children aged <18 years.

Compared with IIV, fewer data are available concerning the use of LAIV in the setting of egg allergy. In a prospective cohort study of children aged 2 through 16 years (69 with egg allergy and 55 without), all of whom received LAIV, none of the egg-allergic subjects developed signs or symptoms of an allergic reaction during the one hour of postvaccination observation, and none reported adverse reactions that were suggestive of allergic reaction or which required medical attention after 24 hours (*36*). In a larger study of 282 egg-allergic children aged 2 through 17 years (115 of whom had experienced anaphylactic reactions to egg previously), no systemic allergic reactions were observed after LAIV administration. On the basis of these data, the upper limit of the 95% confidence interval for the incidence of a systemic allergic reaction (including anaphylaxis) in children with egg allergy was estimated to be 1.3% (*37*). Eight children experienced milder, self-limited symptoms which may have been caused by an IgE-mediated reaction. ACIP will continue to review safety data for use of LAIV in the setting of egg allergy.

For the 2015–16 influenza season, ACIP recommends the following:

1. Persons with a history of egg allergy who have experienced only hives after exposure to egg should receive influenza vaccine. Because relatively few data are available for use of LAIV in this setting, IIV or trivalent recombinant influenza vaccine (RIV3) should be used. RIV3 may be used for persons aged ≥18 years who have no other contraindications. However, IIV (egg- or cell culture-based) may also be used, with the following additional safety measures (Figure 2):
   - Vaccine should be administered by a health care provider who is familiar with the potential manifestations of egg allergy; and
   - Vaccine recipients should be observed for ≥30 minutes for signs of a reaction after administration of each vaccine dose.
2. Persons who report having had reactions to egg involving such symptoms as angioedema, respiratory distress, lightheadedness, or recurrent emesis; or who required epinephrine or another emergency medical intervention, may receive RIV3 if they are aged ≥18 years and there are no other contraindications. If RIV3 is not available or the recipient is not within the indicated age range, IIV should be administered by a physician with experience in the recognition and management of severe allergic conditions (Figure 2).
3. Regardless of allergy history, all vaccines should be administered in settings in which personnel and equipment for rapid recognition and treatment of anaphylaxis are available (*38*).
4. Persons who are able to eat lightly cooked egg (e.g., scrambled egg) without reaction are unlikely to be allergic. Egg-allergic persons might tolerate egg in baked products (e.g., bread or cake). Tolerance to egg-containing foods does not exclude the possibility of egg allergy. Egg allergy can be confirmed by a consistent medical history of adverse reactions to eggs and egg-containing foods, plus skin and/or blood testing for immunoglobulin E directed against egg proteins (*39*).
5. For persons with no known history of exposure to egg, but who are suspected of being egg-allergic on the basis of previously performed allergy testing, consultation with a physician with expertise in the management of allergic conditions should be obtained before vaccination

(Figure 2). Alternatively, RIV3 may be administered if the recipient is aged ≥18 years.

6. A previous severe allergic reaction to influenza vaccine, regardless of the component suspected of being responsible for the reaction, is a contraindication to future receipt of the vaccine.

Vaccine Selection and Timing of Vaccination for Immunocompromised Persons

Immunocompromised states are caused by a heterogeneous range of conditions. In many instances, limited data are available regarding the use of influenza vaccines in the setting of specific immunocompromised states. In general, live virus vaccines, such as LAIV, should not be used for persons with most forms of altered immunocompetence (*38*). The Infectious Diseases Society of America (IDSA) has published detailed guidance for the selection and timing of vaccines for persons with specific immunocompromising conditions, including congenital immune disorders, stem cell and solid organ transplant, anatomic and functional asplenia, and therapeutic drug-induced immunosuppression, as well as for persons with cochlear implants or other conditions leading to persistent cerebrospinal fluid-oropharyngeal communication (*40*). ACIP will continue to review accumulating data on use of influenza vaccines in these contexts.

[1]Influenza Division, National Center for Immunization and Respiratory Diseases, CDC; [2]Battelle Memorial Institute, Atlanta, Georgia; [3]Immunization Safety Office, National Center for Emerging and Zoonotic Infectious Diseases, CDC; [4]Johns Hopkins University, Baltimore, Maryland.

Corresponding author: Lisa A. Grohskopf, lgrohskopf@cdc.gov, 404-639-2552.

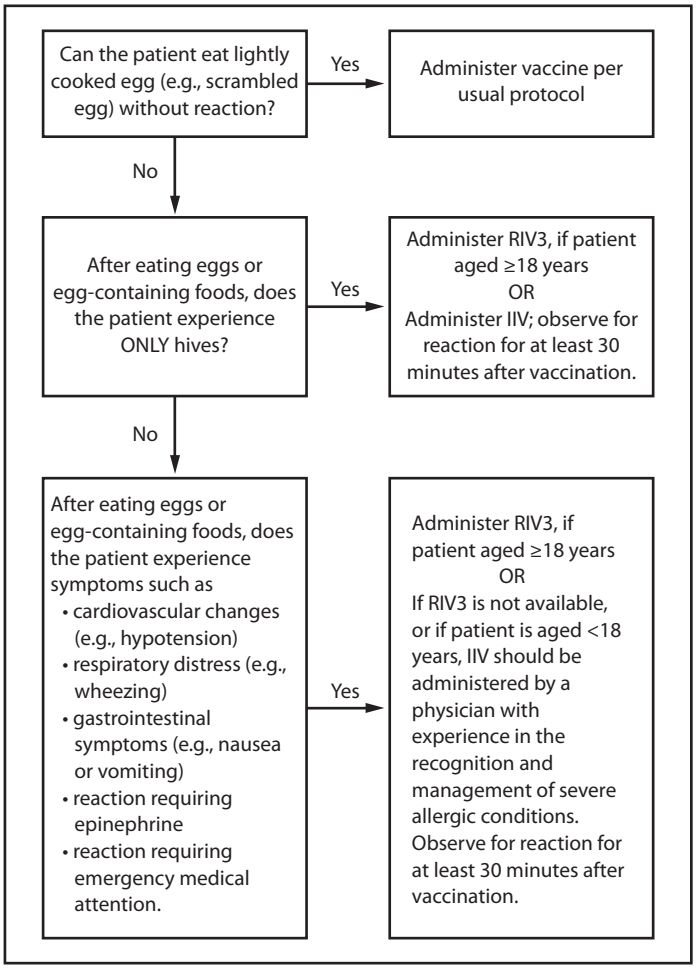
Acknowledgments

ACIP members (membership roster for July 2014–June 2015 is available at http://www.cdc.gov/vaccines/acip/committee/members.html). ACIP Influenza Work Group; Alicia Fry, MD, Brendan Flannery, PhD, Jessie Clippard, MPH, Influenza Division, National Center for Immunization and Respiratory Diseases, CDC; Angelia Cost, PhD, Armed Forces Health Surveillance Center.

ACIP Influenza Work Group

Ruth Karron, MD, Baltimore, Maryland (Chair); Kevin Ault, MD, Kansas City, Kansas; Edward Belongia, MD, Marshfield, Wisconsin; Henry Bernstein, DO, Hempstead, New York; Jeff Duchin, MD, Seattle, Washington; Janet Englund, MD, Seattle, Washington; Sandra Fryhofer, MD, Atlanta, Georgia; Lee H. Harrison, MD, Pittsburgh, Pennsylvania; Lisa Ipp, MD, New York, New York; Wendy Keitel, MD, Houston, Texas; Marie-Michèle Léger, MPH, Alexandria, Virginia; Susan Lett, MD, Jamaica Plain, Massachusetts; Jamie Loehr, MD, Ithaca, New York; Kathleen M. Neuzil, MD, Baltimore, Maryland; William Schaffner, MD, Nashville, Tennessee; Robert Schechter, MD, Richmond, California; Kenneth Schmader, MD, Durham, North Carolina; Tamara Sheffield, MD, Salt Lake City, Utah; Nadine Sicard, MD, Montreal, Quebec, Canada; Patricia Stinchfield, MS, St. Paul, Minnesota; Matthew Zahn, MD, Santa Ana, California.

FIGURE 2. Recommendations regarding influenza vaccination of persons who report allergy to eggs*† — Advisory Committee on Immunization Practices, United States, 2015–16 influenza season



Abbreviations: IIV = inactivated influenza vaccine, trivalent or quadrivalent; RIV3 = recombinant influenza vaccine, trivalent.

* Persons with egg allergy may tolerate egg in baked products (e.g., bread or cake). Tolerance to egg-containing foods does not exclude the possibility of egg allergy (Erlewyn-Lajeunesse et al., Recommendations for the administration of influenza vaccine in children allergic to egg. BMJ 2009;339:b3680).

† For persons who have no known history of exposure to egg, but who are suspected of being egg-allergic on the basis of previously performed allergy testing, consultation with a physician with expertise in the management of allergic conditions should be obtained prior to vaccination. Alternatively, RIV3 may be administered if the recipient is aged ≥18 years.

References

1. Grohskopf LA, Olsen SJ, Sokolow LZ, et al. Prevention and control of seasonal influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices (ACIP) — United States, 2014–15 influenza season. MMWR Morb Mortal Wkly Rep 2014;63:691–7.
2. CDC. Prevention and control of seasonal influenza with vaccines. recommendations of the Advisory Committee on Immunization Practices—United States, 2013–14. MMWR Recomm Rep 2013;62(No. RR-7):1–43.
3. Ochiai H, Shibata M, Kamimura K, Niwayama S. Evaluation of the efficacy of split-product trivalent A(H1N1), A(H3N2), and B influenza vaccines: reactogenicity, immunogenicity and persistence of antibodies following two doses of vaccines. Microbiol Immunol 1986;30:1141–9.

4. Künzel W, Glathe H, Engelmann H, Van Hoecke C. Kinetics of humoral antibody response to trivalent inactivated split influenza vaccine in subjects previously vaccinated or vaccinated for the first time. Vaccine 1996;14:1108–10.
5. Song JY, Cheong HJ, Hwang IS, et al. Long-term immunogenicity of influenza vaccine among the elderly: Risk factors for poor immune response and persistence. Vaccine 2010;28:3929–35.
6. Skowronski DM, Tweed SA, De Serres G. Rapid decline of influenza vaccine-induced antibody in the elderly: is it real, or is it relevant? J Infect Dis 2008;197:490–502.
7. Castilla J, Martínez-Baz I, Martínez-Artola V, et al. Network for Influenza Surveillance in Hospitals of Navarre. Decline in influenza vaccine effectiveness with time after vaccination, Navarre, Spain, season 2011/12. Euro Surveill 2013;18:20388.
8. Food and Drug Administration. 138th Meeting of the Vaccines and Related Biological Produces Advisory Committee, March 4, 2015 [Transcript]. Washington, DC: Food and Drug Administration; 2015. Available at http://www.fda.gov/downloads/AdvisoryCommittees/CommitteesMeetingMaterials/BloodVaccinesandOtherBiologics/VaccinesandRelatedBiologicalProductsAdvisoryCommittee/UCM438843.pdf.
9. bioCSL. Afluria: Influenza Vaccine [Package insert]. King of Prussia, PA: bioCSL; 2015. Available at http://www.fda.gov/downloads/BiologicsBloodVaccines/Vaccines/ApprovedProducts/UCM263239.pdf.
10. McAllister L, Anderson J, Werth K, et al. Needle-free jet injection for administration of influenza vaccine: a randomised non-inferiority trial. Lancet 2014;384:674–81.
11. Protein Sciences. Flublok: Influenza Vaccine [Package insert]. Meriden, CT: Protein Sciences; 2015. Available at http://www.fda.gov/downloads/BiologicsBloodVaccines/Vaccines/ApprovedProducts/UCM336020.pdf.
12. Keitel WA, Treanor JJ, El Sahly HM, et al. Comparative immunogenicity of recombinant influenza hemagglutinin (rHA) and trivalent inactivated vaccine (TIV) among persons ≥65 years old. Vaccine 2009;28:379–85.
13. Baxter R, Patriarca PA, Ensor K, Izikson R, Goldenthal KL, Cox MM. Evaluation of the safety, reactogenicity and immunogenicity of FluBlok® trivalent recombinant baculovirus-expressed hemagglutinin influenza vaccine administered intramuscularly to healthy adults 50–64 years of age. Vaccine 2011;29:2272–8.
14. National Institutes of Health. Comparison of the safety of Flublok® versus licensed IIV in healthy, medically stable adults ≥50 years of age [Internet]. Bethesda, MD: National Institutes of Health; 2015. Clinical study record no. NC0125200. Available from: https://clinicaltrials.gov/ct2/show/NCT01825200.
15. Sanofi Pasteur. Fluzone Intradermal Quadrivalent vaccine [Package insert]. Swiftwater, PA: Sanofi Pasteur; 2015. Available at http://www.fda.gov/downloads/BiologicsBloodVaccines/Vaccines/ApprovedProducts/UCM426679.pdf.
16. Gorse GJ, Falsey AR, Ozol-Godfrey A, Landolfi V, Tsang PH. Safety and immunogenicity of a quadrivalent intradermal influenza vaccine in adults. Vaccine 2015;33:1151–9.
17. Neuzil KM, Jackson LA, Nelson J, et al. Immunogenicity and reactogenicity of 1 versus 2 doses of trivalent inactivated influenza vaccine in vaccine-naive 5–8-year-old children. J Infect Dis 2006;194:1032–9.
18. Allison MA, Daley MF, Crane LA, et al. Influenza vaccine effectiveness in healthy 6- to 21-month-old children during the 2003-2004 season. J Pediatr 2006;149:755–62.
19. Ritzwoller DP, Bridges CB, Shetterly S, Yamasaki K, Kolczak M, France EK. Effectiveness of the 2003–2004 influenza vaccine among children 6 months to 8 years of age, with 1 vs 2 doses. Pediatrics 2005;116:153–9.
20. Englund JA, Walter EB, Gbadebo A, Monto AS, Zhu Y, Neuzil KM. Immunization with trivalent inactivated influenza vaccine in partially immunized toddlers. Pediatrics 2006;118:e579–85.
21. Englund JA, Walter EB, Fairchok MP, Monto AS, Neuzil KM. A comparison of 2 influenza vaccine schedules in 6- to 23-month-old children. Pediatrics 2005;115:1039–47.
22. Walter EB, Neuzil KM, Zhu Y, et al. Influenza vaccine immunogenicity in 6- to 23-month-old children: are identical antigens necessary for priming? Pediatrics 2006;118:e570–8.
23. Ambrose CS, Levin MJ, Belshe RB. The relative efficacy of trivalent live attenuated and inactivated influenza vaccines in children and adults. Influenza Other Respir Viruses 2011;5:67–75.
24. Belshe RB, Edwards KM, Vesikari T, et al.; CAIV-T Comparative Efficacy Study Group. Live attenuated versus inactivated influenza vaccine in infants and young children. N Engl J Med 2007;356:685–96.
25. Ashkenazi S, Vertruyen A, Arístegui J, et al.; CAIV-T Study Group. Superior relative efficacy of live attenuated influenza vaccine compared with inactivated influenza vaccine in young children with recurrent respiratory tract infections. Pediatr Infect Dis J 2006;25:870–9.
26. Fleming DM, Crovari P, Wahn U, et al.; CAIV-T Asthma Study Group. Comparison of the efficacy and safety of live attenuated cold-adapted influenza vaccine, trivalent, with trivalent inactivated influenza virus vaccine in children and adolescents with asthma. Pediatr Infect Dis J 2006;25:860–9.
27. Advisory Committee on Immunization Practices (ACIP). Summary Report: October 29–30, 2014 (Meeting minutes). Washington, DC: US Department of Health and Human Services, CDC; 2014. Available at http://www.cdc.gov/vaccines/acip/meetings/downloads/min-archive/min-2014-10.pdf.
28. Advisory Committee on Immunization Practices (ACIP). Summary Report: February 26, 2015 (Meeting minutes). Washington, DC: US Department of Health and Human Services, CDC; 2015. Available at http://www.cdc.gov/vaccines/acip/meetings/downloads/min-archive/min-2015-02.pdf.
29. Medimmune. Flumist Quadrivalent [Draft of package insert]. Gaithersburg, MD: MedImmune; 2015 Available at http://www.fda.gov/downloads/BiologicsBloodVaccines/Vaccines/ApprovedProducts/UCM294307.pdf.
30. Des Roches A, Paradis L, Gagnon R, Lemire C, Begin P, Carr S, et al. Egg-allergic patients can be safely vaccinated against influenza. J Allergy Clinical Immunol 2012;130:1213–6 e1.
31. Kelso JM, Greenhawt MJ, Li JT; Joint Task Force on Practice Parameters (JTFPP). Update on influenza vaccination of egg allergic patients. Ann Allergy Asthma Immunol 2013;111:301–2.
32. Advisory Committee on Immunization Practices (ACIP). Summary Report: June 20–21, 2012 (Meeting minutes). Washington, DC: US Department of Health and Human Services, CDC; 2012. Available at http://www.cdc.gov/vaccines/acip/meetings/downloads/min-archive/min-jun12.pdf.
33. Advisory Committee on Immunization Practices (ACIP). Summary Report: June 19–20, 2013 (Meeting minutes). Washington, DC: US Department of Health and Human Services, CDC; 2013. Available at http://www.cdc.gov/vaccines/acip/meetings/downloads/min-archive/min-jun13.pdf.
34. Kelso JM, Greenhawt MJ, Li JT, et al. Adverse reactions to vaccines practice parameter 2012 update. J Allergy Clin Immunol 2012;130:25–43.
35. Owens G, MacGinnitie A. Higher-ovalbumin-content influenza vaccines are well tolerated in children with egg allergy. J Allergy Clin Immunol 2011;127:264–5.
36. Des Roches A, Samaan K, Graham F, et al. Safe vaccination of patients with egg allergy by using live attenuated influenza vaccine. J Allergy Clin Immunol Pract 2015;3:138–9.
37. Turner PJ, Southern J, Andrews NJ, Miller E, Erlewyn-Lajeunesse M, SNIFFLE Study Investigators. Safety of live attenuated influenza vaccine in atopic children with egg allergy. J Allergy Clinical Immunol 2015; pii: S0091–6749(15)00005–6.
38. CDC. General recommendations on immunization—recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2011;60(No. RR-2):1–64.
39. Erlewyn-Lajeunesse M, Brathwaite N, Lucas JS, Warner JO. Recommendations for the administration of influenza vaccine in children allergic to egg. BMJ 2009;339:b3680.
40. Rubin LG, Levin MJ, Ljungman P, et al.; Infectious Diseases Society of America. 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. Clin Infect Dis 2014;58:e44–100.

Vital Signs: Estimated Effects of a Coordinated Approach for Action to Reduce Antibiotic-Resistant Infections in Health Care Facilities — United States

Rachel B. Slayton, PhD[1]; Damon Toth, PhD[2]; Bruce Y. Lee, MD[3]; Windy Tanner, PhD[2]; Sarah M. Bartsch, MPH[3]; Karim Khader, PhD[2]; Kim Wong, PhD[4]; Kevin Brown, PhD[2]; James A. McKinnell, MD[5]; William Ray[2]; Loren G. Miller, MD[6]; Michael Rubin, MD, PhD[2]; Diane S. Kim[7]; Fred Adler, PhD[8]; Chenghua Cao, MPH[7]; Lacey Avery, MA[1]; Nathan T.B. Stone, PhD[9]; Alexander Kallen, MD[1]; Matthew Samore, MD[2]; Susan S. Huang, MD[7]; Scott Fridkin, MD[1]; John A. Jernigan, MD[1]

On August 4, 2015, this report was posted as an MMWR *Early Release on the* MMWR *website (http://www.cdc.gov/mmwr).*

Abstract

Background: Treatments for health care–associated infections (HAIs) caused by antibiotic-resistant bacteria and *Clostridium difficile* are limited, and some patients have developed untreatable infections. Evidence-supported interventions are available, but coordinated approaches to interrupt the spread of HAIs could have a greater impact on reversing the increasing incidence of these infections than independent facility-based program efforts.

Methods: Data from CDC's National Healthcare Safety Network and Emerging Infections Program were analyzed to project the number of health care–associated infections from antibiotic-resistant bacteria or *C. difficile* both with and without a large scale national intervention that would include interrupting transmission and improved antibiotic stewardship. As an example, the impact of reducing transmission of one antibiotic-resistant infection (carbapenem-resistant *Enterobacteriaceae* [CRE]) on cumulative prevalence and number of HAI transmission events within interconnected groups of health care facilities was modeled using two distinct approaches, a large scale and a smaller scale health care network.

Results: Immediate nationwide infection control and antibiotic stewardship interventions, over 5 years, could avert an estimated 619,000 HAIs resulting from CRE, multidrug-resistant *Pseudomonas aeruginosa*, invasive methicillin-resistant *Staphylococcus aureus* (MRSA), or *C. difficile*. Compared with independent efforts, a coordinated response to prevent CRE spread across a group of inter-connected health care facilities resulted in a cumulative 74% reduction in acquisitions over 5 years in a 10-facility network model, and 55% reduction over 15 years in a 102-facility network model.

Conclusions: With effective action now, more than half a million antibiotic-resistant health care–associated infections could be prevented over 5 years. Models representing both large and small groups of interconnected health care facilities illustrate that a coordinated approach to interrupting transmission is more effective than historical independent facility-based efforts.

Implications for Public Health: Public health–led coordinated prevention approaches have the potential to more completely address the emergence and dissemination of these antibiotic-resistant organisms and *C. difficile* than independent facility–based efforts.

Introduction

With the continuing emergence of antibiotic resistance, treatments for bacterial infections are increasingly limited, and in some patients, effective treatment options do not exist. Antibiotics are a lifesaving medical tool, and antibiotic resistance undermines the ability to fight infectious diseases. CDC estimates that antibiotic-resistant bacteria cause 2 million illnesses and approximately 23,000 deaths each year in the United States (*1*). Infections caused by resistant pathogens have the potential to affect persons both in and out of health care settings. In addition, almost 250,000 persons each year require hospital care for *C. difficile* infections (CDIs), which are typically associated with antibiotic use (*1*). Despite success in preventing these infections at individual health care facilities (*2*,*3*), the continued spread of antibiotic resistant pathogens and *C. difficile* has outpaced the development of new therapies (*1*).

Historically, infection control interventions designed to prevent spread of *C. difficile* and antibiotic-resistant pathogens have been independently implemented by individual health care facilities, without clear coordination among other facilities in the community, which often care for the same

patients. Although improvements within independent facilities are necessary, they might not be sufficient to reduce spread. These independent efforts do not account for the importance of inter-facility spread through movement of patients who are colonized or infected with these organisms, or the impact that one institution's practices might have on the antibiotic resistance encountered by neighboring facilities (*4*–*6*). To date, even when fully implemented, this independent facility–based effort has not adequately controlled inter-facility spread of antibiotic-resistant pathogens (*7*). In addition to optimizing implementation of infection control in every facility, an inter-facility coordinated approach to interrupt spread, facilitated by local or state-based oversight, has the potential to more effectively reduce the overall prevalence of antibiotic-resistant infections across all health care facilities within a community. The impact of such coordinated responses can be estimated through mathematical modeling, and assessment of the expected benefits can inform the development and implementation of these programs.

Methods

Estimating infection incidence and deaths. Projections of infections and deaths in the United States during 2014–2019 were derived from data obtained through CDC's National Healthcare Safety Network (NHSN) and Emerging Infections Program (EIP). Four particularly problematic health care–associated infections (HAIs) were included: CRE, multidrug-resistant *Pseudomonas aeruginosa*, invasive MRSA, and CDIs (*1*). To estimate the percentage of antibiotic-resistant HAIs over the next 5 years, logarithmic models for multidrug-resistant *P. aeruginosa* and CRE were generated from the annual percentage of resistant isolates from device and procedure–associated HAIs reported to NHSN during 2009–2013, and the percentage resistant by year was estimated through 2019. To obtain the annual number of infections, the 2011 national estimates of pathogen-specific HAIs were multiplied by the projected percentage resistant for each pathogen (*8*). Projections for invasive MRSA and CDI were derived from EIP national surveillance from 2005–2012 for MRSA and 2011 for CDI (*3*,*9*). Mortality rates from EIP data or published literature were applied to the projected number of infections to determine associated mortality (*1*). Estimated numbers of infections and deaths averted with the implementation of an immediate national intervention were based on published reports of national interventions in other countries, where interventions combining interrupting transmission with improved inpatient antibiotic prescribing resulted in roughly 30%–50% fewer infections over 5 years (reductions varied by pathogen) (*10*–*12*).

Estimating effect of a coordinated approach in a network. Two independently developed and complementary agent-based mathematical simulation models were used to measure the impact of a coordinated approach to prevent the spread of antibiotic-resistant organisms within a group of health care facilities interconnected through patient sharing (i.e., a network), using CRE as a test case. These agent-based models are computer simulations that represent hospitalized patients as "agents" and track their dynamic interactions with other patients and CRE status throughout the health care system. The first model assessed the impact of the coordinated approach in a simulated network of 10 health care facilities consisting of four acute care hospitals (including one long-term acute care hospital), and six free-standing nursing homes serving adult patients. Transfer of patients between facilities was calibrated based on actual transfer data from the U.S. Department of Veterans Affairs, supplemented with state inpatient database data (*11*). The period used to measure the impact was 5 years. The second model assessed the impact of a coordinated approach in a larger region and used the Regional Healthcare Ecosystem Analyst (RHEA), a simulation based on data from the network of all 28 acute care hospitals (including five long-term acute care hospitals) and 74 free-standing nursing homes serving adult patients in Orange County, California. The RHEA model, originally developed to simulate MRSA transmission (*13*–*16*), was re-parameterized to simulate spread of CRE within this larger health care network, and the period used to measure impact was 15 years.

With each model, the spread of CRE was simulated under three hypothetical scenarios (*1*): infection control activity currently in common use (common approach/status quo, or baseline activity with no augmented intervention) (*2*), augmented efforts implemented independently at individual subsets of facilities (independent efforts), and (*3*) coordinated augmented approach across a health care network (coordinated approach). Baseline activity simulations assumed that facilities applied contact precautions only to colonized or infected patients identified through routine tests. The independent efforts allowed for up to 15% of hospitals to begin active detection (i.e., CRE surveillance cultures) and isolation of CRE-colonized patients after a predetermined number of patients had been identified through routine clinical tests at each individual hospital. The coordinated approach allowed for all health care facilities to share CRE test results with a central public health authority, which used that information to strategically target prevention activity across multiple facilities. Notification of patient status as CRE-colonized or CRE-infected to facilities receiving a patient upon inter-facility transfer varied by model, and increased in frequency from independent efforts to coordinated approaches.

Both models simulated the movement of patients within and between different health care facilities and transmission of CRE in a health care network based upon key parameter estimates that included inter-facility patient movement, the proportion of colonized patients recognized by routine clinical tests, and effectiveness of barrier precautions in preventing transmission. Models were parameterized based on published data or calibrated to published estimates of CRE incidence and prevalence at acute care hospitals, long-term acute care hospitals, and nursing homes in regions where CRE outbreaks have occurred. Mean values for number of acquisitions and cumulative prevalence were calculated from simulations.*

Results

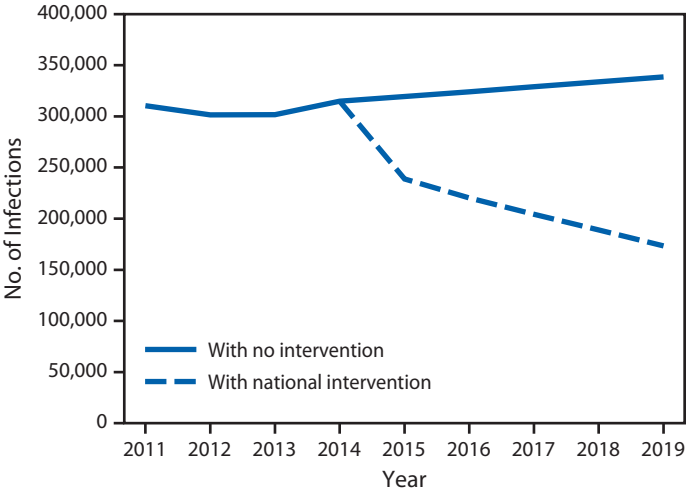
Projected national incidence of infections and deaths from several resistant organisms. In 2011, an estimated 310,000 HAIs from CRE, multidrug-resistant *P. aeruginosa*, invasive MRSA, or CDI occurred in the United States. Based on current trends, in 5 years the number of infections caused by these pathogens is estimated to increase by approximately 10%, to 340,000 per year, unless additional interventions are implemented. With immediate implementation of national interventions combining infection control and antibiotic stewardship and, assuming similar effectiveness to that reported in other countries, an estimated 619,000 health care–associated infections and 37,000 deaths could be averted in 5 years (Figure 1).

Estimated effect of coordinated approach in a network for reducing CRE spread. For the 10-facility model, after the first introduction of CRE into the network, with baseline activity alone (no augmented intervention), the prevalence of health care–associated CRE infection or colonization after 5 years could be 12.2% with 2,141 patients acquiring CRE (Figure 2). With independent facility–augmented efforts, the prevalence of CRE after 5 years could be 8.6% with 1,590 patient acquisitions of CRE. Simulating a coordinated augmented approach, the model predicts a prevalence of 2.1% with 406 patient acquisitions after 5 years; the coordinated response resulted in a cumulative 81% reduction in CRE acquisitions, with 1,735 patient acquisitions prevented when compared with baseline activity (Figure 2) and a 74% reduction when compared with independent-facility efforts (Figure 2). On average, over this 5-year period, the coordinated approach resulted in 35 patients protected from CRE acquisition per 1,000 screening tests compared with 11 patients per 1,000 screening tests with the independent-facility efforts.†

*Additional information available at http://www.cdc.gov/drugresistance/resources/publications.html.

† A video of the model simulations is available at http://www.cdc.gov/drugresistance/resources/videos.html.

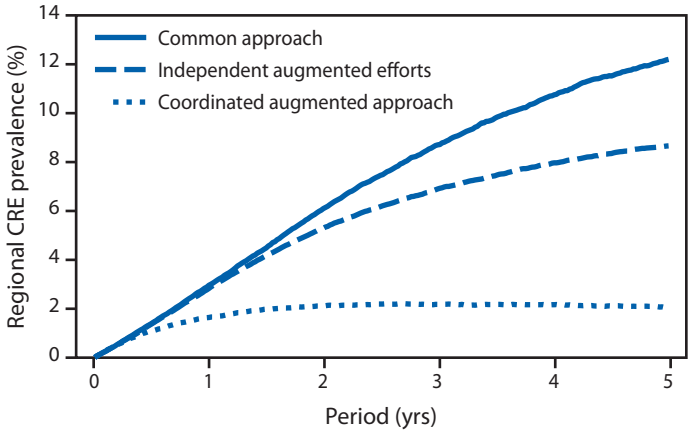
FIGURE 1. Comparison between the projected number of annual health care–associated infections from selected antibiotic-resistant bacteria* and *Clostridium difficile* with no intervention and the projected number with an aggressive national intervention — United States, 2014–2019†



* Methicillin-resistant *Staphlococcus aureus*, carbapenem-resistant *Enterobacteriaceae*, and multidrug-resistant *Pseudomonas aeruginosa*.

† Additional information available at http://www.cdc.gov/drugresistance/resources/publications.html.

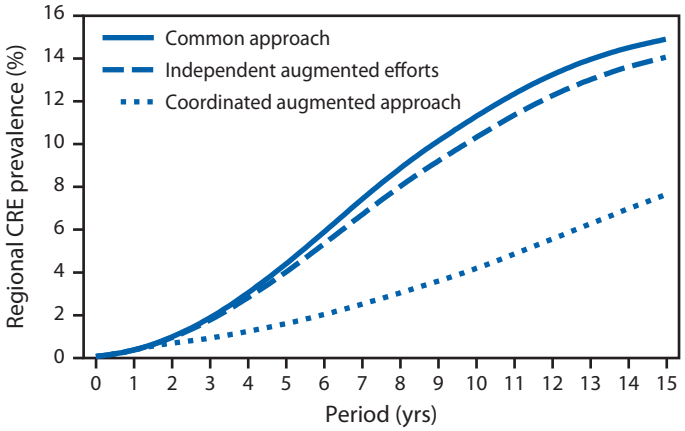
FIGURE 2. Projected regional prevalence of carbapenem-resistant *Enterobacteriaceae* (CRE) over a 5-year period under three different intervention scenarios — 10-facility model, United States*



* Additional information available at http://www.cdc.gov/drugresistance/resources/publications.html. A video of the model simulations is available at http://www.cdc.gov/drugresistance/resources/videos.html.

Using the 102-facility model of Orange County simulations over 15 years, the model estimated that the average network prevalence of CRE after 15 years would be 15% with 35,159 patients acquiring CRE (Figure 3). With independent facility-augmented efforts, the average network prevalence of CRE after 15 years could be 14% with 31,885 patient acquisitions of CRE. Simulating a coordinated approach in a network, the model predicted an average prevalence after 15 years of 8%

FIGURE 3. Projected countywide prevalence of carbapenem-resistant *Enterobacteriaceae* (CRE) over a 15-year period under three different intervention scenarios — 102-facility model, Orange County, California*



* Additional information available at http://www.cdc.gov/drugresistance/resources/publications.html.

with 12,614 patient acquisitions. Over 15 years, the coordinated response resulted in a cumulative 55% reduction in CRE prevalence with 19,271 patient acquisitions prevented, compared with independent-facility efforts.

Conclusions and Comment

With effective action now, including nationwide antibiotic stewardship efforts and interventions to prevent spread of antibiotic-resistant infections, an estimated 619,000 infections caused by three problematic antibiotic-resistant HAIs or CDIs, and 37,000 deaths among infected patients might be averted nationally over the next 5 years. When considering published estimates of costs related to these four infections in the projections (*17*,*18*), an estimated $7.7 billion in direct medical costs could be averted (not including costs of implementing interventions). Optimizing implementation of basic infection control practice within individual facilities will be of fundamental importance to this effort. Further, models representing both large and small networks of interconnected health care facilities illustrate that a coordinated approach to interrupting transmission is more effective than traditional approaches that have relied on individual hospital efforts to independently identify and implement interventions. Incorporating such coordinated approaches at a national level could help ensure such actions are effective.

Several methods exist to coordinate prevention of antibiotic resistant HAIs; however, public health departments, particularly large local or state health departments, are uniquely suited to facilitate and accelerate this approach. Health departments are able to work with facilities within their jurisdiction in ways that amplify ongoing efforts of individual facilities or health systems. Because health departments possess substantial expertise in surveillance and prevention, they are well equipped to partner with multiple stakeholders, including hospitals, corporate and academic institutions, hospital associations, professional organizations, quality improvement organizations, and federal partners. Such state-based HAI antibiotic-resistance prevention programs can enable communities to locate the threat by sharing antibiotic resistance data and promoting accurate testing. Such programs also can respond quickly to prevent spread by identifying and rapidly responding to clusters, implementing a regionally coordinated response that includes opening lines of communication between facilities, helping individual hospitals improve infection prevention practices, and strategically targeting resources to prevent spread and maximize community impact.

Sharing the responsibilities to establish a coordinated program among communities of health care institutions with leadership by local health authorities will bring about the collective, shared benefits of coordination. Shifting the current culture to one of sharing information and sharing responsibility in prevention will require local leadership and commitment across various sectors. Developing a plan to share facility-level information regarding the presence and incidence of important antibiotic-resistant infections in ways that acknowledge the importance of protecting personally identifiable and other sensitive information, as occurred with

Key Points

- Antibiotic use can cause germs to become resistant to antibiotics. Their use can also cause *Clostridium difficile* infections, which are quite contagious, especially in health care facilities.
- About 2 million illnesses and 23,000 deaths are caused by antibiotic resistant infections in the United States annually.
- About 250,000 people are hospitalized for *C. difficile* infections annually, typically caused by antibiotic use.
- If best infection control practices and antibiotic stewardship were nationally adopted, more than 600,000 infections and 37,000 deaths could be prevented over 5 years.
- If health care sites coordinated their patient infection information to guide interventions, an estimated 74% fewer patients would be infected by highly-resistant carbapenem-resistant Enterobacteriaceae over 5 years.
- Additional information is available at http://www.cdc.gov/vitalsigns.

facility-specific disclosure of HAI rates over the past decade, will be essential. Several key steps need to be taken to begin a coordinated approach. Health care facility leaders can take action to accelerate efforts to improve infection control practices within their own facilities and assure accurate and timely detection and reporting of antibiotic-resistant infections. In addition to augmented efforts, facilities can alert one another when enhanced infection control is needed for transferred patients who are colonized or infected with resistant organisms. Facility leadership should work with their respective health departments to determine best data sharing practices. Such steps improve access by public health departments to an established flow of HAI data, including those reported from hospitals to CDC's NHSN. CDC is working to better assist health departments and health care facilities to collect, access, and respond to their HAI-related data, thereby enabling more efficient use of staff time and resources to implement effective prevention efforts.

A number of states have begun to develop programmatic capacity and experience in a coordinated approach for action to prevent antibiotic-resistant infections in health care settings. For example, the South Dakota Department of Health identified CRE in a region of the state, and in response, implemented a comprehensive program that included the introduction of mandatory reporting of CRE in 2013. The educational program was developed to increase CRE prevention knowledge among health care providers, and, with the two main hospital systems in the state, develop and implement interventions to reduce transmission. The program determines extent of spread and has worked with neighboring states to prevent cross-border transmission. This coordinated approach in oversight and rapid and efficient response resulted in a statewide decrease in CRE infections from 24 in 2012, to four in 2014. In Tennessee, the Department of Health has begun accessing data reported to NHSN and using analytic methods similar to The Targeted Assessment for Prevention[§] strategy developed by CDC to target health care facilities with a disproportionate burden of CDI presenting to the hospital from the community or other facilities such as nursing homes. Such a strategy can identify gaps in infection prevention and antibiotic stewardship outside of hospitals. The Tennessee approach allows for prioritization of prevention efforts to the places where they will have their greatest impact. In Illinois, the Department of Public Health serves as a broker of data to all facilities in the state, maintaining a registry of patients infected or colonized with extensively drug-resistant bacteria. Currently, this registry is being used to report and identify patients with a history of CRE colonization or infection. Any registered facility can use the state-based notifiable disease reporting system to access the registry and determine if an anticipated admission involves a patient with a history of CRE. This allows appropriate infection control precautions to be taken at the time of admission.

The findings in this report are subject to at least five limitations. First, estimates of the projected number of infections and the impact of interventions are based on the assumption that rates will rise yearly according to current trends and that effective interventions will reduce annual rates of infections by 30%–50%. Second, reductions in infections with these four pathogens over the next 5 years might not translate into fewer HAIs overall; however, even if the infections prevented with these four pathogens are replaced by infections caused by less resistant organisms, such infections would be easier to treat. Third, the models were focused on interventions that are designed for interrupting transmission within and between health care facilities. Antibiotic resistant pathogens, such as MRSA, can also be spread in community settings; parallel efforts to prevent AR in the community are also of great importance. Fourth, illustration of the impact of coordinated approaches to preventing transmission as presented here is based on current understanding of CRE transmission within facilities and inter-facility transfer patterns, and some of the simplifying assumptions used in the simulations might bias the results. The use of Veterans Affairs data in the 10-facility model made it feasible to represent dependencies between lengths of stay, probabilities of readmission, and infection status. These are relationships that, in their basic form, likely are generalizable across health systems, and other models using different assumptions have suggested a similar advantage to regionally coordinated interventions involving other pathogens (*4*,*5*). Although the model assumptions incorporate active detection and isolation of CRE patients, the benefits illustrated in the model would be the same for any intervention (e.g., augmented hand hygiene efforts or skin antisepsis) that reduces transmission by the amount incorporated into the models. The analysis assumes no more than 15% of hospitals would implement augmented independent efforts. If a larger number of facilities implemented augmented independent efforts, the relative benefits of the coordinated approach would be lower, although as illustrated in the analysis, the resource utilization is much more efficient with coordination. Finally, the projected impact of interventions nationally include data for only four of the most problematic pathogens identified in the CDC Threat Assessment (*1*). These were chosen because they are propagated primarily in health care settings, are particularly difficult to treat, and have great potential to spread. Of note, the cost estimates assume the infections are not simply replaced with more susceptible bacteria and do not take into account the costs of implementing prevention programs, although a

[§] Additional information available at http://www.cdc.gov/hai/prevent/tap.html.

study on CDI prevention suggests such multifaceted prevention programs would be cost-saving (*18*).

The threat of antibiotic-resistant infections and CDI is not limited to certain areas or types of health care facilities. The current threat of antibiotic resistance in health care settings suggests that historical independent institution-based efforts to prevent transmission have been inadequate. Coordinated prevention approaches led by public health agencies, when coupled with intensified facility-based prevention programs, have the potential to more completely address the emergence and dissemination of these organisms.

[1]National Center for Emerging and Zoonotic Infectious Diseases; [2]VA Salt Lake City Health Care System and Division of Epidemiology, University of Utah, [3]Public Health Computational and Operations Research, Johns Hopkins Bloomberg School of Public Health, [4]Center for Simulation and Modeling, University of Pittsburgh; [5]Torrance Memorial Medical Center; [6]Infectious Disease Clinical Outcomes Research Unit, Los Angeles Biomedical Research Institute, Harbor-UCLA Medical Center; [7]Division of Infectious Diseases and Health Policy Research Institute, University of California Irvine Health School of Medicine; [8]Department of Mathematics, University of Utah; [9]Pittsburgh Super Computing Center.

Corresponding author: Rachel Slayton, rslayton@cdc.gov, 404-639-4566.

Acknowledgments

Emerging Infections Programs participants (Colorado Department of Public Health and Environment; Oregon Public Health Authority; New York–Rochester Emerging Infections Program and University of Rochester Medical Center; Tennessee Department of Health; Minnesota Department of Health; Connecticut Department of Public Health; California Emerging Infections Program; Georgia Emerging Infections Program; Atlanta VA Medical Center; Emory University School of Medicine, Atlanta, Georgia; New Mexico Department of Health; Maryland Emerging Infections Program; Maryland Department of Health and Mental Hygiene). Agency for Healthcare Research and Quality; University of Pittsburgh Center for Simulation and Modeling; VA Salt Lake City Health Care System.

References

1. CDC. Antibiotic resistance threats in the United States, 2013. Atlanta, GA: US Department of Health and Human Services, CDC; 2013. Available at http://www.cdc.gov/drugresistance/threat-report-2013.
2. Burton DC, Edwards JR, Horan TC, Jernigan JA, Fridkin SK. Methicillin-resistant *Staphylococcus aureus* central line-associated bloodstream infections in US intensive care units, 1997-2007. JAMA 2009;301:727–36.
3. Dantes R, Mu Y, Belflower R, et al.; Emerging Infections Program–Active Bacterial Core Surveillance MRSA Surveillance Investigators. National burden of invasive methicillin-resistant *Staphylococcus aureus* infections, United States, 2011. JAMA Intern Med 2013;173:1970–8.
4. Real LA. The community-wide dilemma of hospital-acquired drug resistance. Proc Natl Acad Sci U S A 2005;102:2683–4.
5. Smith DL, Dushoff J, Perencevich EN, Harris AD, Levin SA. Persistent colonization and the spread of antibiotic resistance in nosocomial pathogens: resistance is a regional problem. Proc Natl Acad Sci U S A 2004;101:3709–14.
6. Lin MY, Lyles-Banks RD, Lolans K, et al.; Centers for Disease Control and Prevention Epicenters Program. The importance of long-term acute care hospitals in the regional epidemiology of *Klebsiella pneumoniae* carbapenemase-producing *Enterobacteriaceae.* Clin Infect Dis 2013;57:1246–52.
7. Munoz-Price LS, Hayden MK, Lolans K, et al. Successful control of an outbreak of *Klebsiella pneumoniae* carbapenemase-producing *K. pneumoniae* at a long-term acute care hospital. Infect Control Hosp Epidemiol 2010;31:341–7.
8. Magill SS, Edwards JR, Bamberg W, et al.; Emerging Infections Program Healthcare-Associated Infections and Antimicrobial Use Prevalence Survey Team. Multistate point-prevalence survey of health care-associated infections. N Engl J Med 2014;370:1198–208.
9. Lessa FC, Mu Y, Bamberg WM, et al. Burden of *Clostridium difficile* infection in the United States. N Engl J Med 2015;372:825–34.
10. Agha M. Epidemiology and pathogenesis of *C. difficile* and MRSA in the light of current NHS control policies: a policy review. Ann Med Surg (Lond) 2012;1:39–43.
11. Public Health England. Annual epidemiological commentary: Mandatory MRSA, MSSA and *E. coli* bacteraemia and *C. difficile* infection data, 2013/14. London, United Kingdom: PHE Publications; 2014. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/330529/HCAI_mandatory_surveillance_annual_epidemiological_commentary_2013_14.pdf.
12. Schwaber MJ, Lev B, Israeli A, et al.; Israel Carbapenem-Resistant *Enterobacteriaceae* Working Group. Containment of a country-wide outbreak of carbapenem-resistant *Klebsiella pneumoniae* in Israeli hospitals via a nationally implemented intervention. Clin Infect Dis 2011;52:848–55.
13. Lee BY, Bartsch SM, Wong KF, et al. The importance of nursing homes in the spread of methicillin-resistant *Staphylococcus aureus* (MRSA) among hospitals. Med Care 2013;51:205–15.
14. Lee BY, Wong KF, Bartsch SM, et al. The Regional Healthcare Ecosystem Analyst (RHEA): a simulation modeling tool to assist infectious disease control in a health system. J Am Med Inform Assoc 2013;20(e1):e139–46.
15. Office of Statewide Health Planning and Development. California inpatient data reporting manual: medical information reporting for California. 7th edition. Available at http://www.oshpd.ca.gov/hid/mircal/IPManual.html.
16. Centers for Medicare & Medicaid Services. Long term care minimum data set. Available at http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/NursingHomeQualityInits/index.html.
17. Roberts RR, Hota B, Ahmad I, et al. Hospital and societal costs of antimicrobial-resistant infections in a Chicago teaching hospital: implications for antibiotic stewardship. Clin Infect Dis 2009;49:1175–84.
18. Slayton RB, Scott RD, Baggs J, Lessa FC, McDonald LC, Jernigan JA. The cost-benefit of federal investment in preventing *Clostridium difficile* infections through the use of a multifaceted infection control and antimicrobial stewardship program. Infect Control Hosp Epidemiol 2015;36:681–7.

Notes from the Field

Lack of Measles Transmission to Susceptible Contacts from a Health Care Worker with Probable Secondary Vaccine Failure — Maricopa County, Arizona, 2015

Jefferson Jones, MD[1,2]; Ron Klein[2]; Saskia Popescu, MPH[3]; Karen Rose[2]; Melissa Kretschmer, MA[2]; Alice Carrigan, MS[2]; Felicia Trembath, MPH[2,4]; Lia Koski, MPH[2]; Karen Zabel, MSN[2]; Scott Ostdiek, MD[3]; Paula Rowell-Kinnard, MSN[3]; Esther Munoz[3]; Rebecca Sunenshine, MD[2,5]; Tammy Sylvester, MSN[2]

On January 23, 2015, the Maricopa County Department of Public Health (MCDPH) was notified of a suspected measles case in a nurse, a woman aged 48 years. On January 11, the nurse had contact with a patient with laboratory-confirmed measles associated with the Disneyland theme park–related outbreak in California (*1*). On January 21, she developed a fever (103°F [39.4°C]), on January 23 she experienced cough and coryza, and on January 24, she developed a rash. The patient was instructed to isolate herself at home. On January 26, serum, a nasopharyngeal swab, and a urine specimen were collected. The following day, measles infection was diagnosed by real time reverse transcription polymerase chain reaction testing of the nasopharyngeal swab and urine specimen and by detection of measles-specific immunoglobulin (Ig)M and IgG in serum by enzyme-linked immunosorbent assay. Because of her symptoms and laboratory results, the patient was considered to be infectious.

The case patient had documentation of receipt of 2 doses of measles-mumps-rubella (MMR) vaccine in 1991 and 1992. In 2006, the patient had received negative measles IgG serology test results; however, according to recommendations of the Advisory Committee on Immunization Practices, she was presumed to be immune because she had received two MMR doses (*2*).

The presence of measles IgG (index standard ratio = 8.2, with ≥1.1 considered seropositive) 2 days after rash onset suggested secondary vaccine failure (waning of vaccine-induced immunity, rather than failure to develop an immune response to administered vaccine [i.e., primary vaccine failure]). Symptoms in these patients range from typical measles to a much milder, modified illness (*3*). Secondary measles vaccine failure is uncommon, and although measles transmission from such persons has been documented (*4*), it is not believed to contribute significantly to spread (*5*).

The patient worked at a tertiary pediatric outpatient health care facility during January 20–21, a period which coincided with her infectious period. In cooperation with the health care facility, an investigation was conducted to prevent further transmission by identifying contacts, providing postexposure prophylaxis, recommending quarantine for unvaccinated contacts, and providing education for rapid isolation and diagnosis of symptomatic contacts (*6*). The health care facility identified 71 health care workers (HCWs) and 195 patients who had been exposed to the nurse on the 2 days she had worked; all 71 HCWs had documented receipt of ≥2 doses of MMR vaccine or serologic proof of measles immunity.

During January 26–30, the health care facility, in consultation with MCDPH, attempted to reach families of exposed patients by telephone; one to three telephone calls were made to each household. A total of 144 (74%) of 195 potentially exposed patients and their family members (total = 380 persons) were contacted (>72 hours after exposure). MMR vaccination status (receipt of ≥1 dose) and measles symptoms were ascertained by telephone interview for exposed patients and family members (Table). Fifty-one patients (among 47 families) could not be contacted, and the Arizona State Immunization Information System was accessed to verify their MMR vaccination status. The status of persons whose records listed no MMR vaccination history was considered unknown. Assuming that one adult (with unknown MMR vaccine status) accompanied each family, a total of 478 patients and family members were potentially exposed. Among the 478, 40 (8%) were considered to be potentially susceptible: 10 were unvaccinated persons without other evidence of measles immunity in non-high–risk

TABLE. Number of contacts* exposed to an MMR-vaccinated health care worker† with measles, by age group and MMR vaccination status — Maricopa County, Arizona, 2015

Age group	Total	Immunocompromised	History of measles disease	MMR vaccination status		
				≥1 dose	No doses	Unknown
0–11 months	21	0	0	0	21	0
1–17 years§	210	9	0	166	8	27
≥18 years§	228	0	2	145	2	79¶
Unknown	19	0	0	13	0	6
Total	**478**	**9**	**2**	**324**	**31**	**112**

Abbreviation: MMR = measles, mumps, and rubella.
* Includes only patients and their family members.
† Health care worker had documented receipt of two MMR doses, but history of negative measles IgG serology test results.
§ Includes 50 persons aged 1–17 years and one person aged ≥18 years using the Arizona State Immunization Information System (ASIIS) records for MMR history; any ASIIS records with no MMR vaccine history were considered unknown.
¶ Fifty-one patients (among 47 families) could not be contacted; assumed one adult accompanied each patient or family of patients for siblings (i.e., the parent or guardian).

groups (eight children aged 1–11 years and two adults aged 26 and 38 years), and 30 were persons in high-risk groups (21 infants aged <1 year, and therefore too young for routine MMR vaccination, and nine immunocompromised persons). Immune globulin was administered to 15 (71%) infants and eight (89%) immunocompromised patients within 6 days of their exposure.*

After 21 days had elapsed from the last measles exposure, calls to families of the 195 patients were attempted; 106 (54%) families responded and reported that no exposed family members had developed a febrile rash illness. No measles cases were reported in Maricopa County. These findings are consistent with previous reports demonstrating limited transmission from persons with secondary measles vaccine failure. In addition, the risk for transmission was reduced because all exposed HCWs had been vaccinated for measles.

HCWs born after 1956 should have documentation of receipt of 2 doses of MMR vaccine or laboratory evidence of measles immunity (*2*). Secondary vaccine failure occurs rarely, but transmission of measles to susceptible persons in these situations appears to be unlikely. If a patient is suspected of having measles, HCWs should implement airborne precautions (*6*). Case investigation and contact tracing should be conducted for all U.S. measles cases, regardless of vaccination history or occupation (*6*), and a history of travel should be solicited for any patient with a febrile rash illness (*7*). 2 doses of MMR vaccine, administered ≥28 days apart, are recommended for children aged ≥12 months and adults born after 1956, for prevention of measles.

*Among seven persons who did not receive immune globulin, one had recently received an immune globulin dose, one could not be reached, one was traveling outside the country, two were contacted more than 6 days after exposure, and two refused.

Acknowledgment

Kathryn Fitzpatrick, MS, Arizona Public Health Laboratory, Arizona Department of Health Services.

[1]Epidemic Intelligence Service, CDC; [2]Maricopa County Department of Public Health, Phoenix, Arizona; [3]Phoenix Children's Hospital, Arizona; [4]Health Systems Integration Program, CDC; [5]Career Epidemiology Field Officer Program, CDC.

Corresponding author: Jefferson M. Jones, JJones10@cdc.gov, 602-376-8251.

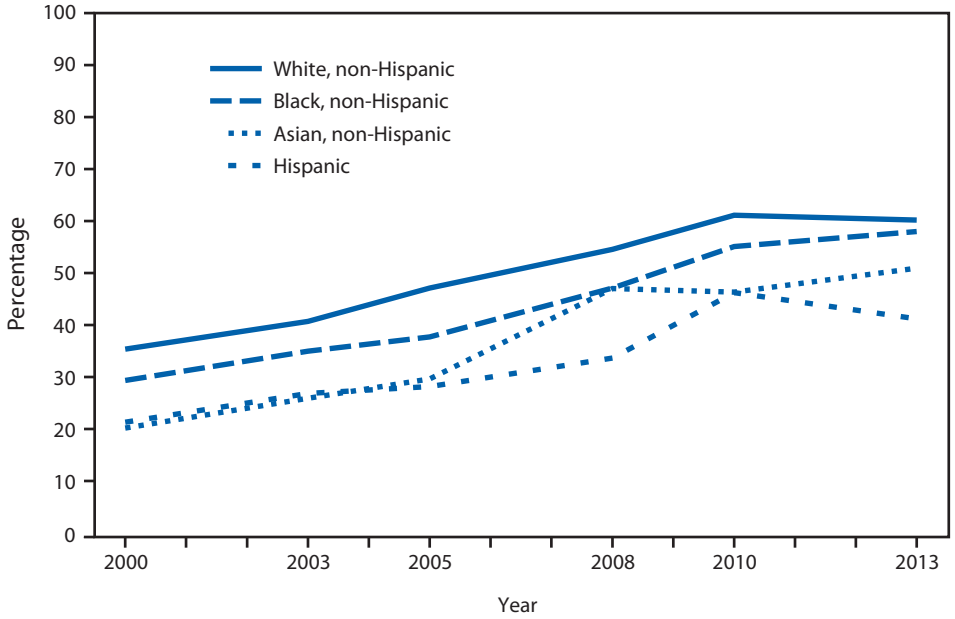
References

1. Zipprich J, Winter K, Hacker J, Xia D, Watt J, Harriman K. Measles outbreak—California, December 2014–February 2015. MMWR Morb Mortal Wkly Rep 2015;64:153–4.
2. McLean HQ, Fiebelkorn AP, Temte JL, Wallace GS. Prevention of measles, rubella, congenital rubella syndrome, and mumps, 2013: summary recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2013;62(No. RR-4):1–34.
3. Lievano FA, Papania MJ, Helfand RF, et al. Lack of evidence of measles virus shedding in people with inapparent measles virus infections. J Infect Dis 2004;189(Suppl 1):S165–70.
4. Rota JS, Hickman CJ, Sowers SB, Rota PA, Mercader S, Bellini WJ. Two case studies of modified measles in vaccinated physicians exposed to primary measles cases: high risk of infection but low risk of transmission. J Infect Dis 2011;204(Suppl 1):S559–63.
5. Rosen JB, Rota JS, Hickman CJ, et al. Outbreak of measles among persons with prior evidence of immunity, New York City, 2011. Clin Infect Dis 2014;58:1205–10.
6. Kutty P, Rota J, Bellini W, Redd SB, Barskey A, Wallace G. Measles [Chapter 7]. In: Wharton M, Roush S, eds. Manual for the surveillance of vaccine-preventable diseases. Atlanta, GA: US Department of Health and Human Services, CDC; 2008.
7. Wilson ME. Fever in Returned Travelers. In: CDC Health Information for International Travel 2014 [Chapter 5]. New York: Oxford University Press; 2014.

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Colorectal Cancer Screening* Among Adults Aged 50–75 Years, by Race and Hispanic Origin† — National Health Interview Survey,§ United States, 2000–2013



* Includes reports of home fecal occult blood test (FOBT) in the past year, sigmoidoscopy procedure in the past 5 years with FOBT in the past 3 years, or colonoscopy in the past 10 years, based on the most recent guidelines from the U.S. Preventive Services Task Force. Colorectal cancer tests and procedures are performed for diagnostic and screening purposes.

† Categories of non-Hispanic persons are for respondents who selected one racial group; respondents had the option to select more than one racial group. Hispanic origin refers to persons who are of Hispanic ethnicity and might be of any race or combination of races. Non-Hispanic refers to all persons who are not of Hispanic ethnicity, regardless of race.

§ Estimates are based on household interviews of a sample of the civilian noninstitutionalized population. Questions about colorectal tests or procedures differed slightly on the National Health Interview Survey and were asked on an intermittent schedule in 2000, 2003, 2005, 2008, 2010, and 2013. Additional information available at http://www.cdc.gov/nchs/data/hus/hus14.pdf (page 404).

During 2000–2013, among adults aged 50–75 years, the use of colorectal cancer tests or procedures increased for all racial and ethnic groups shown. Non-Hispanic Asian adults had the largest increase; the percentage more than doubled from 20.6% in 2000 to 51.2% in 2013. Although increases were observed among all groups, in 2013 the prevalence of colorectal cancer screening remained higher among non-Hispanic white (60.4%) and non-Hispanic black (58.2%) adults and lower among non-Hispanic Asian (51.2%) and Hispanic (41.5%) adults.

Source: Health, United States, 2014 (with special feature on adults aged 55–64, Table 78). Available at http://www.cdc.gov/nchs/data/hus/hus14.pdf.

Reported by: Hashini Khajuria, MPA, hwq6@cdc.gov, 301-458-4253.

The *Morbidity and Mortality Weekly Report (MMWR)* Series is prepared by the Centers for Disease Control and Prevention (CDC) and is available free of charge in electronic format. To receive an electronic copy each week, visit *MMWR*'s free subscription page at *http://www.cdc.gov/mmwr/mmwrsubscribe.html*. Paper copy subscriptions are available through the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone 202-512-1800.

Readers who have difficulty accessing this PDF file may access the HTML file at *http://www.cdc.gov/mmwr/index2015.html*. Address all inquiries about the *MMWR* Series, including material to be considered for publication, to Executive Editor, *MMWR* Series, Mailstop E-90, CDC, 1600 Clifton Rd., N.E., Atlanta, GA 30329-4027 or to mmwrq@cdc.gov.

All material in the *MMWR* Series is in the public domain and may be used and reprinted without permission; citation as to source, however, is appreciated.

Use of trade names and commercial sources is for identification only and does not imply endorsement by the U.S. Department of Health and Human Services.

References to non-CDC sites on the Internet are provided as a service to *MMWR* readers and do not constitute or imply endorsement of these organizations or their programs by CDC or the U.S. Department of Health and Human Services. CDC is not responsible for the content of these sites. URL addresses listed in *MMWR* were current as of the date of publication.

ISSN: 0149-2195