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Electronic Cigarette Use Among Working Adults — United States, 2014

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Electronic cigarettes (e-cigarettes) are battery-powered devices that deliver a heated aerosol, which typically contains nicotine, flavorings, and other additives, to the user. The e-cigarette marketplace is rapidly evolving, but the long-term health effects of these products are not known. Carcinogens and toxins such as diacetyl, acetaldehyde, and other harmful chemicals have been documented in the aerosol from some e-cigarettes (*1–3*). On May 5, 2016, the Food and Drug Administration (FDA) finalized a rule extending its authority to all tobacco products, including e-cigarettes.* The prevalence of e-cigarette use among U.S. adults has increased in recent years, particularly among current and former conventional cigarette smokers (*4*); in 2014, 3.7% of all U.S. adults, including 15.9% of current cigarette smokers, and 22.0% of former cigarette smokers, used e-cigarettes every day or some days (*5*). The extent of current e-cigarette use among U.S. working adults has not been assessed. Therefore, CDC analyzed 2014 National Health Interview Survey (NHIS) data for adults aged ≥18 years who were working during the week before the interview, to provide national estimates of current e-cigarette use among U.S. working adults by industry and occupation. Among the estimated 146 million working adults, 3.8% (5.5 million) were current (every day or some days) e-cigarette users; the highest prevalences were among males, non-Hispanic whites, persons aged 18–24 years, persons with annual household income <$35,000, persons with no health insurance, cigarette smokers, other combustible tobacco users, and smokeless tobacco users. By industry and occupation, workers in the accommodation and food services industry and in the food preparation and serving-related occupations had the highest prevalence of current e-cigarette use. Higher prevalences of e-cigarette use among specific groups and the effect of e-cigarette use on patterns of conventional tobacco use underscore the importance of continued surveillance of e-cigarette use among U.S. working adults to inform public health policy, planning, and practice.

NHIS data are collected annually from a nationally representative sample of the noninstitutionalized U.S. civilian population through a personal household interview. The NHIS adult core questionnaire is administered to a randomly selected adult aged ≥18 years in each sampled household. In 2014, the NHIS adult sample included 36,697 respondents and the response rate was 58.9% (*6*). The NHIS collected information on e-cigarette use for the first time in 2014.

Survey participants were considered to be currently working if they reported "working at a job or business," "with a job or business but not at work," or "working, but not for pay, at a family-owned job or business" during the week before the interview. Information on participants' industry of

* https://federalregister.gov/articles/2016/05/10/2016-10685/deeming-tobacco-products-to-be-subject-to-the-federal-food-drug-and-cosmetic-act-as-amended-by-the.

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employment and occupation was classified by the National Center for Health Statistics using a standardized coding system (*6*). Current e-cigarette users were adults who answered "yes" to the question about having ever used an e-cigarette, even one time in the past, and who then reported that they currently used e-cigarettes every day or some days at the time of the survey (*5*). Current e-cigarette use was also assessed within subgroups defined by current cigarette smoking, use of other combustible tobacco products (cigars/little cigars/cigarillos, bidis, pipes, or water pipes/hookahs), and current use of smokeless tobacco products (chewing tobacco/snuff/dip, snus, or dissolvable tobacco). Current cigarette smokers were respondents who reported smoking ≥100 cigarettes during their lifetime, and who reported smoking every day or some days at the time of the survey. Former smokers were respondents who reported smoking ≥100 cigarettes during their lifetime, and reported not smoking at the time of the survey. Never smokers were respondents who reported not having smoked 100 cigarettes during their lifetime. Current other combustible tobacco smokers were respondents who reported ever smoking other tobacco products (including cigars/little cigars/cigarillos, bidis, pipes, or water pipes/hookahs), even one time, and who reported smoking other tobacco products every day, some days, or rarely at the time of the survey. Current smokeless tobacco users were respondents who reported ever using smokeless tobacco products that are placed in the mouth or nose (including chewing tobacco, snuff, dip, snus, or dissolvable tobacco, snuff or chewed tobacco), even one time, and who reported use every day, some days, or rarely at the time of the survey.

Data were adjusted for nonresponse and weighted to provide nationally representative estimates. Prevalence estimates and corresponding 95% confidence intervals were calculated. E-cigarette use was assessed overall, and by age, sex, race/ethnicity, education, annual household income, health insurance status, U.S. census region, perceived health status, current cigarette smoking, other combustible tobacco use, and smokeless tobacco use. Estimates with a relative standard error >30% are not reported. Two-sided t-tests[†] were used to determine statistically significant ($p<0.05$) differences between point estimates.

In 2014, an estimated 146 million U.S. adults were working during the week before the NHIS interview. Among working adults, 3.8% (an estimated 5.5 million) were current e-cigarette users. The prevalences of current e-cigarette use were significantly ($p<0.05$) higher among males (4.5%) and non-Hispanic whites (4.5%), and among persons aged 18–24 years (5.1%), with annual family income <$35,000 (5.1%), with no health insurance (5.9%), residing in the Midwest region (4.5%), and with fair or poor health (5.7%) than among females (3.0%) and non-Hispanic blacks (1.9%), and persons aged 45–64 years (2.9%), with income >$75,000 (2.6%), with health insurance (3.4%), residing in the Northeast region (2.0%), and with excellent health (2.4%) (Table 1). E-cigarette use was also

[†] http://www.cdc.gov/nchs/data/series/sr_10/sr10_256.pdf (page 142).

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TABLE 1. Current e-cigarette* use prevalence among currently working† adults aged ≥18 years, by selected characteristics — National Health Interview Survey, United States, 2014

Characteristic	Estimated population§ (x 1,000)	Estimated e-cigarette use** No.¶ (x 1,000)	% (95% CI)
Total	**146,324**	**5,498**	**3.8 (3.2–4.3)**
Age group (yrs)			
18–24	18,401	940	5.1 (3.7–6.6)
25–44	63,593	2,879	4.5 (3.9–5.2)
45–64	56,641	1,620	2.9 (2.1–3.7)
≥65	7,689	60	0.8 (0.3–1.2)
Sex			
Male	77,846	3,452	4.5 (3.6–5.3)
Female	68,478	2,046	3.0 (2.5–3.5)
Race/Ethnicity			
Hispanic	23,477	584	2.5 (1.7–3.3)
White, non-Hispanic	96,846	4,314	4.5 (3.7–5.2)
Black, non-Hispanic	16,629	321	1.9 (1.4–2.5)
Other	9,372	279	3.0 (1.7–4.3)
Education			
≤High school, GED	13,439	490	3.7 (2.5–4.8)
>High school	132,253	5,003	3.8 (3.2–4.4)
Unknown	632	—††	— (—)
Family income ($)			
0–34,999	29,754	1,515	5.1 (4.4–5.9)
35,000–74,999	42,368	1,962	4.6 (3.8–5.5)
≥75,000	62,205	1,716	2.8 (1.7–3.8)
Unknown	11,997	305	2.6 (1.3–3.9)
Health insurance			
Insured	125,316	1,186	3.4 (2.9–3.9)
Not insured	20,170	4,236	5.9 (4.6–7.3)
Unknown	838	—	— (—)
U.S. census region§§			
Northeast	24,940	491	2.0 (1.2–2.7)
Midwest	34,988	1,567	4.5 (3.3–5.7)
South	53,018	2,119	4.0 (2.9–5.1)
West	33,377	1,321	4.0 (3.1–4.8)
Perceived health¶¶			
Excellent	50,419	1,197	2.4 (1.9–2.9)
Good	87,781	3,847	4.4 (3.7–5.1)
Fair/Poor	8,096	454	5.7 (3.1–8.3)
Unknown	28	—	— (—)

Abbreviations: CI = confidence interval; GED = General Educational Development certificate or diploma.

* Current users were adults who used e-cigarettes at least once in their lifetime and currently use every day or some days.

† Adults who reported "working at a job or business"; "with a job or business but not at work"; or "working, but not for pay, at a family-owned job or business" during the week before the interview.

§ Weighted to provide national estimates.

¶ Estimated number of e-cigarette users among working adults.

** E-cigarette use was significantly associated (p<0.05) with age, gender, race, income, health insurance coverage, perceived health status, and region.

†† Estimates suppressed because relative standard error for the estimate was >30%.

§§ http://www.census.gov/econ/census/help/geography/regions_and_divisions.html.

¶¶ Perceived self-reported health categorized on the basis of the response to the question, "Would you say your health in general is excellent, good, fair, or poor?"

significantly (p<0.05) higher among current cigarette smokers (16.2%) and users of other combustible tobacco products (15.0%) or smokeless tobacco (9.7%) than among former (4.3%) and never (0.5%) cigarette smokers, and nonusers of combustible tobacco (2.9%) or smokeless tobacco (3.6%) (Table 2).

By industry, reported e-cigarette use was highest among workers in accommodation and food services (6.9%) and lowest among workers in education services (1.8%). By occupation, prevalences of e-cigarette use were highest among workers in food preparation and serving-related occupations (6.8%) and lowest among workers in business and financial operations occupations (2.3%) (Table 3).

TABLE 2. Estimated prevalence of current e-cigarette* use, by current cigarette smoking status,† current other combustible§ tobacco use status, and current smokeless¶ tobacco use status among working adults aged ≥18 years — National Health Interview Survey, United States, 2014**

Tobacco use	Estimated working population†† (x 1,000)	Estimated current e-cigarette use No.§§ (x 1,000)	% (95% CI)
Cigarette smoking status			
Current	23,739	3,827	16.2 (13.9–18.5)
Former	27,854	1,198	4.3 (3.2–5.4)
Never	93,936	473	0.5 (0.3–0.7)
Unknown	795	—¶¶	— (—)
Other combustible tobacco use§			
Yes	10,519	1,578	15.0 (11.0–19.1)
No	135,103	3,920	2.9 (2.5–3.3)
Unknown	702	—	— (—)
Smokeless tobacco use¶			
Yes	5,139	499	9.7 (6.5–12.9)
No	140,428	4,999	3.6 (3.0–4.1)
Unknown	757	—	— (—)

Abbreviation: CI = confidence interval.

* Current users are adults who used e-cigarettes at least once in their lifetime and currently use every day or some days.

† Current cigarette smokers smoked ≥100 cigarettes during their lifetime and currently smoke every day or somedays. Former cigarette smokers smoked ≥100 cigarettes during their lifetime and currently do not smoke. Never smokers are adults who reported not smoking 100 cigarettes in their lifetime.

§ Used other non-cigarette combustible tobacco products (cigars/little cigars/cigarillos; bidis, pipes, or water pipes/hookahs) at least one time in the past, and currently smoke every day, some days, or rarely.

¶ Used smokeless tobacco products (chewing tobacco/snuff/dip, snus, or dissolvable tobacco) at least one time in the past, and currently use them every day, some days, or rarely.

** Adults who reported "working at a job or business"; "with a job or business but not at work"; or "working, but not for pay, at a family-owned job or business" during the week before the interview.

†† Weighted to provide national estimates for working adults.

§§ Estimated number of e-cigarette users among working adults.

¶¶ Estimates suppressed because relative standard error for the estimate was >30%.

Table 3. Current e-cigarette use* prevalence among currently working† adults aged ≥18 years, by industry and occupation group — National Health Interview Survey, 2014

Industry/Occupation	Estimated population§ (x 1,000)	Estimated current e-cigarette use	
		No. (x 1,000)¶	% (95% CI)
Industries			
Accommodation and food services	10,183	700	6.9 (4.9–8.9)
Wholesale trade	3,569	184	5.2 (2.6–7.8)
Manufacturing	14,981	718	4.8 (2.1–7.5)
Administrative and support and waste management and remediation services	6,341	297	4.7 (2.8–6.5)
Retail trade	14,764	683	4.6 (3.4–5.9)
Construction	8,955	406	4.6 (2.9–6.2)
Other services (except public administration)	7,308	285	3.9 (2.1–5.7)
Arts, entertainment, and recreation	3,172	96	3.0 (1.4–4.6)
Professional, scientific, and technical services	10,720	307	2.9 (1.9–3.9)
Health care and social assistance	19,293	521	2.7 (1.8–3.6)
Public administration	6,849	172	2.5 (1.2–3.8)
Finance and insurance	6,701	153	2.3 (1.2–3.4)
Education services	13,893	249	1.8 (1.0–2.6)
All others††	16,748	637	3.3 (2.4–5.3)
Refused, not ascertained, don't know	2,847	—**	— (—)
Occupations			
Food preparation and serving related	7,863	534	6.8 (4.6–9.0)
Production	8,044	422	5.3 (3.7–6.9)
Office and administrative support	17,389	846	4.9 (3.3–6.4)
Building and grounds cleaning and maintenance	5,811	251	4.3 (2.4–6.3)
Transportation and material moving	8,192	341	4.2 (2.4–6.0)
Sales and related	14,467	580	4.0 (2.8–5.2)
Personal care and service	5,654	221	3.9 (2.1–5.7)
Construction and extraction	7,240	253	3.5 (2.1–4.9)
Healthcare support	3,046	92	3.0 (1.3–4.8)
Management	14,114	368	2.6 (1.7–3.6)
Healthcare practitioners and technical	8,482	206	2.4 (1.5–3.4)
Business and financial operations	7,230	164	2.3 (1.1–3.4)
Architecture and engineering, and computer and mathematical	8,009	148	1.9 (0.9–2.9)
All others§§	27,990	1,005	3.6 (2.1–5.1)
Refused, not ascertained, don't know	2,793	—	— (—)

Abbreviation: CI = confidence interval.

* Current users are adults who used e-cigarettes at least once in their lifetime and currently use every day or some days.

† Adults who reported "working at a job or business"; "with a job or business but not at work"; or "working, but not for pay, at a family-owned job or business" during the week before the interview.

§ Weighted to provide national estimates using the survey sample weights for each participant.

¶ Estimated number of e-cigarette users among working adults.

** Estimates suppressed because relative standard error for the estimate was >30%.

†† Includes all industries with unreliable (relative standard error >30%) estimates combined: mining; transportation and warehousing; utilities; information; real estate, rental, and leasing; agriculture, forestry, fishing and hunting; management of companies and enterprises; and armed forces.

§§ Includes all occupations with unreliable (relative standard error >30%) estimates combined: installation and maintenance and repair; protective services; farming, fishing and forestry, community and social services; arts design, entertainment sports and media; legal, life, physical and social science; education, training, and library; and military occupations.

Discussion

In 2014, an estimated 3.8% of U.S. working adults were current e-cigarette users. Similar to findings previously reported among the overall U.S. adult population (*7*), higher prevalences of current e-cigarette use were observed among workers aged 18–24 years, males, adults with annual household income <$35,000, adults with no health insurance, current and former cigarette smokers, and current users of other combustible tobacco products and smokeless tobacco. Current use of e-cigarettes varied by industry and occupation. Consistent with previous research reports indicating higher conventional cigarette smoking prevalences among workers in the accommodation and food services industry (*8*), prevalences of e-cigarette use were highest among workers in accommodation and food services industry and among workers in food preparation and serving-related occupations. These findings underscore the importance of evidence-based interventions, in coordination with continued surveillance of e-cigarette use among U.S. workers, particularly with regard to concurrent use of e-cigarettes with other tobacco products, to reduce tobacco-related disease and death among this population.

E-cigarettes have been promoted to aid in smoking cessation (*9*); however, the U.S. Preventive Services Task Force has concluded that current evidence is insufficient to recommend e-cigarettes for tobacco cessation among adults,§ and e-cigarettes are not an FDA-approved cessation aid.¶ E-cigarettes also have been marketed as an alternative to smoking in locations where conventional cigarette smoking is prohibited (*9*). Data on the potential health impact of e-cigarette aerosol exposure on users and bystanders are limited (*10*); however, harmful and potentially harmful chemicals have been documented in some e-cigarette cartridges and in the aerosol emitted by these products (*1–3*). Despite uncertainty over the long-term health effects of e-cigarette use, rapid increases have occurred in the awareness, experimentation, and use of these products among U.S. adults (*3*). In May 2016, FDA finalized a rule extending the agency's authority to all tobacco products, including e-cigarettes.

The findings in this report are subject to at least four limitations. First, small sample size limited the precision of estimates for some subpopulations. Second, the NHIS response rate of 58.9% might have resulted in nonresponse bias, even after adjustment for nonresponse. Third, the employment information applied only to jobs held the week before the interview; those jobs might not have been representative of the long-term

§ http://www.uspreventiveservicestaskforce.org/Page/Document/RecommendationStatementFinal/tobacco-use-in-adults-and-pregnant-women-counseling-and-interventions1.

¶ http://www.cdc.gov/niosh/docs/2015-113/pdfs/fy15_cib-67_2015-113_v3.pdf.

Summary

What is already known about this topic?

The prevalence of e-cigarettes use among U.S. adults has increased in recent years, particularly among current and former cigarettes smokers. In 2014, an estimated 3.7% of U.S. adults, including 15.9% of current cigarette smokers and 22.0% of former cigarette smokers, currently used e-cigarettes every day or some days.

What is added by this report?

In 2014, an estimated 5.5 million (3.8%) of 146 million U.S. working adults were current e-cigarette users. An estimated 16.2% of current cigarette smokers, 15.0% of other combustible tobacco users, and 9.7% of smokeless tobacco users currently used e-cigarettes. The highest e-cigarette use prevalence was among workers in accommodation and food services (6.9%) industry, and among workers in food preparation and serving related occupations (6.8%).

What are the implications for public health practice?

Higher prevalences of e-cigarette use among certain groups, coupled with uncertainties regarding the safety of e-cigarette use and the effect of e-cigarette use on patterns of conventional tobacco use, underscore the importance of continued public health surveillance of e-cigarette use among U.S. working adults. Employers, businesses, trade associations, and worker representatives can work in partnership with their state and local health departments to educate workers about the health risks of tobacco use and the benefits of quitting tobacco use completely.

work history of the respondents. Finally, although validity of self-reported smoking status has been confirmed, the accuracy of self-reported e-cigarette use is uncertain.

Recent increases in e-cigarette use among U.S. adults, coupled with uncertainties regarding the safety of e-cigarette use and the effect of e-cigarette use on patterns of conventional tobacco use, underscore the importance of continued public health surveillance of e-cigarette use. Implementation of proven strategies to reduce tobacco use and promote tobacco-free norms in the workplace is also warranted, particularly among populations with the greatest prevalence of use. For example, employers can implement policies prohibiting the use of all forms of tobacco use in the workplace.** Employers can also offer comprehensive tobacco cessation services within their employee health care plans and wellness programs, including coverage of FDA-approved cessation medications (*8*,*10*). Furthermore, employers, businesses, trade associations, and worker representatives can work in partnership with their state and local health departments, to educate workers about the health risks of tobacco use and the benefits of quitting tobacco use completely.

** http://www.acoem.org/uploadedFiles/Public_Affairs/Policies_And_Position_Statements/Guidelines/Guidelines/Guidance_to_Employers_on_Integrating.pdf.

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References

1. Allen JG, Flanigan SS, LeBlanc M, et al. Flavoring chemicals in e-cigarettes: diacetyl, 2,3-pentanedione, and acetoin in a sample of 51 products, including fruit-, candy-, and cocktail-flavored e-cigarettes. Environ Health Perspect 2016;124:733–9. http://dx.doi.org/10.1289/EHP348
2. Callahan-Lyon P. Electronic cigarettes: human health effects. Tob Control 2014;23(Suppl 2):ii36–40. http://dx.doi.org/10.1136/tobaccocontrol-2013-051470
3. Cobb CO, Weaver MF, Eissenberg T. Evaluating the acute effects of oral, non-combustible potential reduced exposure products marketed to smokers. Tob Control 2010;19:367–73. http://dx.doi.org/10.1136/tc.2008.028993
4. King BA, Patel R, Nguyen KH, Dube SR. Trends in awareness and use of electronic cigarettes among US adults, 2010–2013. Nicotine Tob Res 2015;17:219–27. http://dx.doi.org/10.1093/ntr/ntu191
5. Schoenborn CA, Gindi RM. Electronic cigarette use among adults: United States, 2014. NCHS Data Brief no. 217. Hyattsville, MD: US Department of Health and Human Services, CDC; 2015. http://www.cdc.gov/nchs/data/databriefs/db217.pdf
6. CDC. 2014 National Health Interview Survey (NHIS) public use data release: NHIS survey description. Hyattsville, MD: US Department of Health and Human Services, CDC; 2014. ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2014/srvydesc.pdf
7. Jamal A, Homa DM, O'Connor E, et al. Current cigarette smoking among adults—United States, 2005–2014. MMWR Morb Mortal Wkly Rep 2015;64:1233–40. http://dx.doi.org/10.15585/mmwr.mm6444a2
8. CDC. Current cigarette smoking prevalence among working adults—United States, 2004–2010. MMWR Morb Mortal Wkly Rep 2011;60:1305–9.
9. US Department of Health and Human Services. The health consequences of smoking—50 years of progress: a report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, CDC; 2014. http://www.surgeongeneral.gov/library/reports/50-years-of-progress/full-report.pdf
10. Czogala J, Goniewicz ML, Fidelus B, Zielinska-Danch W, Travers MJ, Sobczak A. Secondhand exposure to vapors from electronic cigarettes. Nicotine Tob Res 2014;16:655–62. http://dx.doi.org/10.1093/ntr/ntt203

Elimination of Mother-to-Child Transmission of HIV — Thailand

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Thailand experienced a generalized human immunodeficiency virus (HIV) epidemic during the 1990s. HIV prevalence among pregnant women was 2.0% and the mother-to-child transmission (MTCT) rate was >20% (*1*–*3*). In June 2016, Thailand became the first country in Asia to validate the elimination of MTCT by meeting World Health Organization (WHO) targets. Because Thailand's experience implementing a successful prevention of MTCT program might be instructive for other countries, Thailand's prevention of MTCT interventions, outcomes, factors that contributed to success, and challenges that remain were reviewed. Thailand's national prevention of MTCT program has evolved with prevention science from national implementation of short course zidovudine (AZT) in 2000 to lifelong highly active antiretroviral therapy regardless of CD4 count (WHO option B+) in 2014 (*1*). By 2015, HIV prevalence among pregnant women had decreased to 0.6% and the MTCT rate to 1.9% (the elimination of MTCT target is <2% for nonbreastfeeding populations) (*4*). A strong public health infrastructure, committed political leadership, government funding, engagement of multiple partners, and a robust monitoring system allowed Thailand to achieve this important public health milestone.

Early prevention of MTCT response

The first case of HIV in a pregnant woman in Thailand was reported in 1988 and increasing HIV prevalence among pregnant women and other populations was recognized in the early 1990s (*3*,*5*). In 1996, after the ACTG 076 trial* (*6*), the Thailand Ministry of Public Health (MOPH) and Siriraj Hospital, in collaboration with CDC Thailand/Southeast Asia Regional Office, launched a trial of short-course oral AZT, a regimen feasible for use in Thailand (*2*). The trial demonstrated a 50% reduction in MTCT.

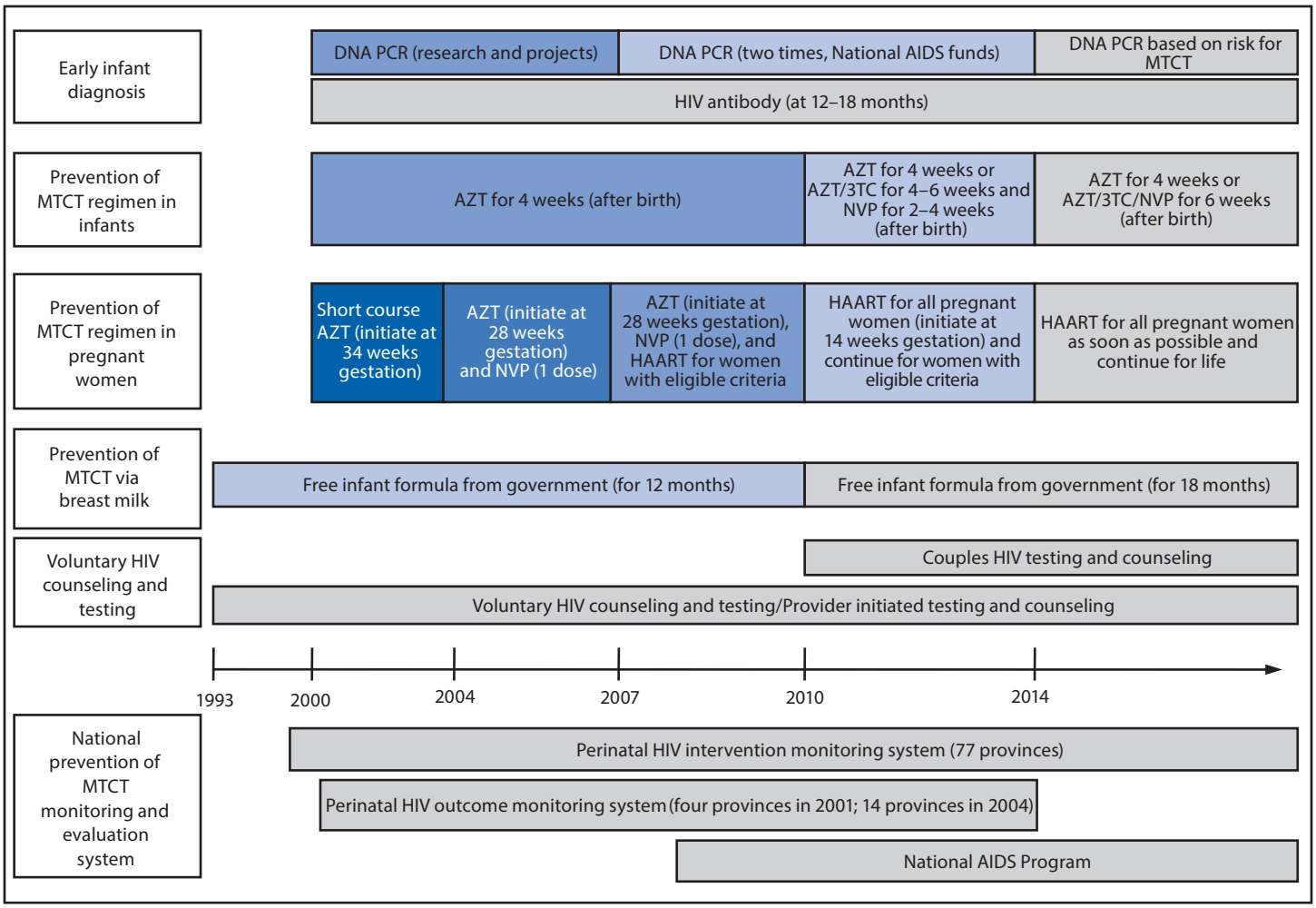
In 1996, Her Royal Highness Princess Soamsawali donated funds to the Thai Red Cross Society to make antiretrovirals for prevention of MTCT available to hospitals around the country. During 1997–1999, the MOPH implemented pilot prevention of MTCT projects in northeastern (*7*) and northern Thailand (*5*) to provide HIV testing for pregnant women and AZT for prevention of MTCT, and to implement a pilot prevention of MTCT monitoring system. In 2000, the Department of Health (DOH) MOPH announced the first national prevention of MTCT policy and issued guidelines for all government hospitals to integrate prevention of MTCT activities into routine maternal and child health services, including HIV testing for all pregnant women, antiretroviral therapy for prevention of MTCT, and infant formula for infants born to HIV-positive mothers. The prevention of MTCT program covers all public and private health care facilities. The Thai government funds prevention of MTCT services for Thais under the universal health coverage policy. During 2007–2014, non-Thai HIV-positive pregnant women could access prevention of MTCT services through a Global Fund project; these services can currently be accessed through hospital social welfare funds, the Princess Soamsawali prevention of MTCT fund, government-sponsored migrant health insurance, or other special projects (*1*) (Figure 1).

Antiretroviral regimens for Thailand's national prevention of MTCT program have evolved with prevention science. In 2000, HIV-positive pregnant women were offered AZT starting at 34 weeks gestation and their infants received AZT for 4 weeks. A single-dose of nevirapine (WHO option A) was added in 2004; next, in 2010, highly active antiretroviral therapy (WHO option B) was provided during pregnancy and continued based on CD4 count; and finally, in 2014, highly active antiretroviral therapy for life regardless of CD4 count (WHO option B+) became the standard. HIV testing of couples was implemented in 2010 (*1*).

Infant HIV testing guidelines have also evolved. During 2000–2006, HIV diagnosis in infants aged 12 months and 18 months was accomplished using antibody tests; diagnoses in some infants aged >2 months were made using DNA polymerase chain reaction (PCR) testing as part of research studies or other projects. In 2007, HIV DNA PCR testing was implemented for infants aged 1–2 months and 2–4 months using national HIV/AIDS funds. In 2014, the national prevention of MTCT guidelines were modified to classify infants based on their risk for acquiring HIV. Infants with standard risk receive AZT for 4 weeks, and HIV DNA PCR testing is performed at age 1 month and 2–4 months. Infants with high risk (maternal plasma HIV viral load >50 copies/mL or infants born to mothers taking highly active antiretroviral therapy for <4 weeks before delivery) receive AZT, lamivudine, and nevirapine for

*ACTG 076 was a Phase III, randomized, double-blind, placebo-controlled clinical trial designed to evaluate whether zidovudine administered orally (initiated at 14–34 weeks gestation) and intravenously during labor to HIV-infected pregnant women and orally to their infants could reduce the rate of transmission from mother to infant.

FIGURE 1. Timeline of the prevention of mother-to-child transmission (MTCT) of HIV policy — Thailand, 1993–2015



Abbreviations: 3TC = lamivudine; AIDS = acquired immunodeficiency syndrome; AZT = zidovudine; HAART = highly active antiretroviral therapy; HIV = human immunodeficiency virus; NVP = nevirapine; PCR = polymerase chain reaction.

6 weeks, and HIV DNA PCR testing is performed at ages 1, 2, and 4 months. All children born to HIV-positive mothers have confirmatory HIV antibody testing at age 18 months (*1*).

Stigma and discrimination against women living with HIV continues to prevent some women from accessing antenatal clinic services (*1*). Women living with HIV in Thailand and civil society organizations have worked with the MOPH to develop and implement a training curriculum for hospital personnel that aims to reduce stigma and discrimination (*1*).

National prevention of MTCT monitoring system

In 2000, the DOH MOPH, with assistance from CDC, launched the Perinatal HIV Intervention Monitoring System (PHIMS) to monitor prevention of MTCT services (*8*). PHIMS collects monthly summaries from hospitals, including HIV testing of pregnant women and their partners, and antiretroviral coverage for prevention of MTCT. PHIMS has been integrated in routine hospital reporting activities, and in 2015, PHIMS covered 837 (92%) governmental hospitals in Thailand (77% of total deliveries including Thais and non-Thais).

Thailand has high levels of health care coverage: 98.3% of pregnant women had at least one antenatal clinic visit in 2015 (elimination of MTCT target >95%) (*4*). The percentage of pregnant women tested for HIV has increased from 61.9% among women in the 1998 prevention of MTCT pilot projects (*7*) to 92.9% in 2001(*8*) after the national prevention of MTCT policy was announced, and to 99.6% in 2015 (elimination of MTCT target >95%) (*1*). The use of antiretrovirals for prevention of MTCT increased from 64.6% in 1998 (*7*) to 71.4% in 2001 (*8*), and to 95.6% in 2015 (elimination of MTCT target >90%) (*1*) (Table).

TABLE. Coverage of prevention of mother-to-child transmission (MTCT) of HIV services using Perinatal HIV Intervention Monitoring System (PHIMS) data for Thai and non-Thai populations — Thailand, July 1998–June 1999, 2001, 2005, 2011, and 2015

Indicator (definition)	Reporting time frame				
	July 1998–June 1999* No. (%) (n = 774,349†)	2001§ No. (%) (n = 766,107†)	2005¶ No. (%) (n = 822,593†)	2011** No. (%) (n = 796,091†)	2015†† No. (%) (n = 736,352†)
Coverage of reporting governmental hospitals	7 (—)§§	793/853¶¶ (93.0)	804/893¶¶ (90.0)	487/868¶¶ (56.1)***	837/914¶¶ (91.6)
Deliveries covered by PHIMS†††	75,308 (9.7)	653,576 (85.3)	692,133 (84.1)	364,455 (45.8)	566,403 (76.9)
Pregnant women receiving antenatal care§§§	74,511 (98.9)	631,344 (96.6)	678,565 (98.0)	356,532 (97.8)	556,773 (98.3)
Coverage of pregnant women tested for HIV§§§	46,648 (61.9)	607,336 (92.9)	688,955 (99.5)	363,848 (99.8)	564,125 (99.6)
Pregnant women testing HIV positive	410 (0.88)	7,659 (1.26)	6,231 (0.90)	2,333 (0.64)	3,399 (0.60)
HIV-positive pregnant women receiving ART for prevention of MTCT§§§	265 (64.6)	5,466 (71.4)	5,584 (89.6)	2,191 (93.9)	3,249 (95.6)
Live infants born to HIV-positive pregnant women	—	7,492 (97.8)	6,037 (96.9)	2,274 (97.5)	3,385 (99.6)
HIV-exposed infants who received ART for PMTCT	—	6,718 (89.7)	5,961 (98.7)	2,238 (98.4)	3,368 (99.5)
Partners tested for HIV	—	—	—	—	239,473 (42.3)
Partners testing HIV positive	—	—	—	—	1,003 (0.4)

Abbreviations: ART = antiretroviral therapy; HIV = human immunodeficiency virus.

* Data from pilot project in region 7 (Northeastern Thailand). Kanshana S, Thewanda D, Teeraratkul A, et al. Implementing short-course zidovudine to reduce mother-infant HIV transmission in a large pilot program in Thailand. AIDS. 2000 Jul 28;14(11):1617–23.

† Total number of deliveries in Thailand. Data from Ministry of Interior.

§ First year data from PHIMS report; 1 year after the national prevention of MTCT policy launched in 2000. 2001 represents October 2000–September 2001 based on Thailand governmental reporting practice; a similar time-frame was used for 2005, 2011, and 2015.

¶ PHIMS data 1 year after WHO option A Prevention of MTCT Policy implemented in Thailand in 2004.

** PHIMS data 1 year after WHO option B Prevention of MTCT Policy implemented in Thailand in 2010.

†† PHIMS data 1 year after WHO option B+ Policy implemented in Thailand in 2014.

§§ Seven provinces in Region 7 (Northeastern Thailand).

¶¶ Number of hospitals reporting/number of hospitals covered by PHIMS.

*** Coverage of PHIMS report was low because of the transition of the PHIMS system from a local network-based system to a web-based system.

††† Number of women reported in PHIMS (% of total deliveries).

§§§ WHO targets for elimination of MTCT of HIV: antenatal care coverage (at least one visit) ≥95%; HIV testing coverage of pregnant women ≥95%; ART coverage of HIV-positive pregnant women ≥90%.

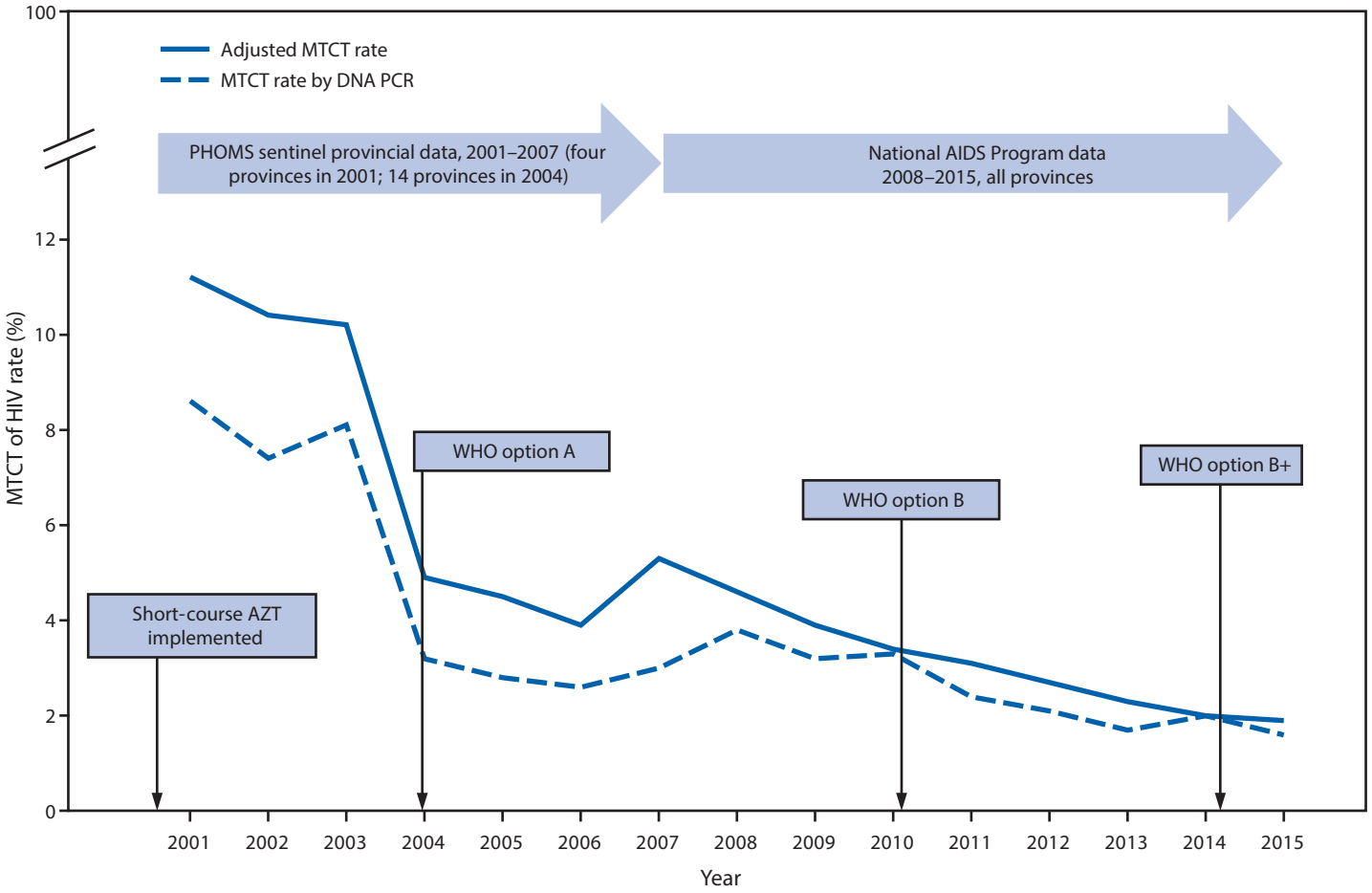
The MOPH Bureau of Epidemiology, with support from CDC, launched the Perinatal HIV Outcome Monitoring System in 2001 (*9*). Providers in 64 public hospitals in four of the country's 77 provinces submitted data, including the number of infants born to HIV-positive mothers, the number of HIV-infected infants, and the MTCT rate, to the Perinatal HIV Outcome Monitoring System, which expanded to 191 facilities in 14 provinces during 2004–2007. In 2008, Thailand established the National AIDS Program to monitor national HIV treatment and care services. MTCT rates were calculated based on infant HIV DNA PCR test results reported in the National AIDS Program. Adjusted MTCT rates during 2001–2012 were calculated to include HIV-exposed infants who were not tested for HIV or whose HIV test results were not reported (*9*,*10*). During 2013–2015, adjusted MTCT rates were calculated using SPECTRUM version 5.4 (*1*).

With the implementation of HIV prevention policies and increased coverage of effective prevention tools (e.g., HIV testing and antiretrovirals for prevention of MTCT) and strong prevention of MTCT monitoring systems, the MTCT rate decreased from 24.2% in 1994 (*2*) to 10.2% in 2003 with the introduction of short-course AZT, to 4.5% with the implementation of WHO option A, and to 1.9% in 2015 after the implementation of WHO option B+ (Figure 2).

Discussion

Thailand has achieved WHO targets for the elimination of MTCT, and is the first country with a generalized HIV epidemic to reach this milestone. The prevalence of HIV among pregnant women has decreased substantially during the past two decades. A combination of factors has made this possible. The Thai government responded to the increasing prevalence of HIV among pregnant women by working with domestic and international medical experts and researchers to assess available data, initiate studies where needed, build the capacity of health care workers, launch national HIV education and 100% condom use campaigns, implement pilot prevention of MTCT activities, gather evidence to develop national policy, and expand activities nationwide. The government also engaged with civil society, persons living with HIV, and nongovernmental organizations to consider appropriate and feasible prevention interventions. A well-developed national health and laboratory system, the integration of prevention of MTCT into routine maternal child health care, and government funding of prevention of MTCT services have been

FIGURE 2. Rate of mother-to-child transmission (MTCT) of HIV* and timeline for introduction of MTCT prevention regimens† — Thailand 2001–2015§



Abbreviations: AIDS = acquired immunodeficiency syndrome; AZT = zidovudine; HIV = human immunodeficiency virus; PCR = polymerase chain reaction; PHOMS = Perinatal HIV Outcome Monitoring System, WHO = World Health Organization.

* The adjusted MTCT rates during 2001–2012 were calculated to include HIV-exposed infants who were not tested for HIV or whose HIV test results were not reported (http://dx.doi.org/10.1097/QAD.0b013e328010e02d; http://dx.doi.org/10.7448/IAS.19.1.20511). The adjusted MTCT rates during 2013–2015 were calculated using SPECTRUM version 5.4 (a software tool developed by the Joint United Nations Programme on HIV/AIDS and partners to assist countries in monitoring their HIV epidemic and provide outputs such as the number of pregnant women and infants infected with HIV). The MTCT rate was calculated based on national infant HIV DNA PCR test results.

† In 2000, HIV-positive pregnant women were offered AZT starting at 34 weeks gestation and their infants received AZT for 4 weeks. A single-dose of nevirapine (WHO option A) was added in 2004; next, in 2010 highly active antiretroviral therapy (WHO option B) was provided during pregnancy and continued based on CD4 count; and finally, highly active antiretroviral therapy for life regardless of CD4 count (WHO option B+) became the standard in 2014.

§ 2001–2007: method of calculation for estimates of MTCT rate described at http://dx.doi.org/10.1097/QAD.0b013e328010e02d; 2008–2012: global AIDS response report 2008–2012; 2013–2015: SPECTRUM version 5.4.

important in attaining high coverage and consistent prevention of MTCT services nationwide. Thailand has a robust national prevention of MTCT monitoring and evaluation system that promotes data use for program improvement at national and subnational levels. As a result, the expanding epidemic of HIV among women was stemmed and MTCT reduced, and fewer infants are born HIV-positive in Thailand.

The findings in this report are subject to at least three limitations. First, nationwide surveillance data about HIV testing coverage and the MTCT rate in the 1980s and 1990s are lacking. Second, assessments of HIV testing and the MTCT rate did not cover 23% of deliveries in 2015. Finally, the DOH sent a prevention of MTCT coverage questionnaire during 2013–2015 to 170 hospitals that are not part of the PHIMS reporting system, including 140 private hospitals, 19 non-MOPH government hospitals, and 11 university hospitals; although only 39% responded, coverage of antenatal clinics, HIV testing, and antiretrovirals for prevention of MTCT met elimination of MTCT targets in the hospitals that responded.

Thailand's national AIDS strategy aims to reduce the MTCT rate to <1% by 2030. Preliminary data from an active case management network launched in Thailand in August 2014

suggested that approximately 80% of new perinatal HIV cases occurred among women who begin antenatal clinic services late, have poor antiretroviral therapy adherence, or test HIV-negative at the first antenatal clinic visit but acquire HIV later (before or after delivery) (*1*). In response, Thailand's National HIV Treatment and Prevention Guideline 2016 will recommend raltegravir, an integrase inhibitor with rapid antiviral activity, for HIV-positive pregnant women who receive care after 32 weeks of pregnancy, and emphasize HIV testing of couples beginning during visits to antenatal clinics and continuing through the postpartum period. Data suggest that to reach a MTCT rate <1%, Thailand will need to strengthen ownership of prevention of MTCT at subnational and community levels, enhance prevention of MTCT monitoring and data use, ensure that HIV-positive migrants have access to HIV services; and sustain the active case management system.

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Summary

What is already known about this topic?

Thailand experienced a generalized human immunodeficiency virus (HIV) epidemic in the 1990s. HIV prevalence among women in antenatal clinics was 2%, and mother-to-child transmission (MTCT) rate of HIV was >20%.

What is added by this report?

Thailand has achieved World Health Organization targets for the elimination of MTCT. With implementation of programs for 100% condom use and HIV prevention, HIV prevalence among pregnant women decreased from 2% in the mid-1990s to 0.6% in 2015. The MTCT rate decreased from >20% to 1.9% because of the effective use of antiretroviral regimens to prevent MTCT, including the adoption of WHO option B+ (lifelong highly active antiretroviral therapy regardless of CD4 count) in 2014, and the high coverage of antenatal care and prevention of MTCT services in Thailand. Factors that contributed to these achievements include the commitment and leadership of the Thai government, a strong public health infrastructure, a self-reliant national budget, the engagement of nongovernmental and civil society partners, and a robust prevention of MTCT monitoring program.

What are the implications for public health?

Thailand has achieved World Health Organization elimination of MTCT targets and can serve as a model for other countries.

References

1. Thailand Ministry of Public Health. Validation of elimination of mother-to-child transmission of HIV and syphilis, Thailand 2013–2015 Report. Nonthaburi, Thailand: Thailand Ministry of Public Health; 2016.
2. Shaffer N, Chuachoowong R, Mock PA, et al.; Bangkok Collaborative Perinatal HIV Transmission Study Group. Short-course zidovudine for perinatal HIV-1 transmission in Bangkok, Thailand: a randomised controlled trial. Lancet 1999;353:773–80. http://dx.doi.org/10.1016/S0140-6736(98)10411-7
3. Bunnell RE, Yanpaisarn S, Kilmarx PH, et al. HIV-1 seroprevalence among childbearing women in northern Thailand: monitoring a rapidly evolving epidemic. AIDS 1999;13:509–15. http://dx.doi.org/10.1097/00002030-199903110-00010
4. World Health Organization. Elimination of mother-to-child transmission (EMTCT) of HIV and syphilis. Global guidance on criteria and processes for validation. Geneva, Switzerland: World Health Organization; 2014. http://www.who.int/hiv/pub/emtct-validation-guidance/en/
5. Thaineua V, Sirinirund P, Tanbanjong A, Lallemant M, Soucat A, Lamboray JL. From research to practice: use of short course zidovudine to prevent mother-to-child HIV transmission in the context of routine health care in Northern Thailand. Southeast Asian J Trop Med Public Health 1998;29:429–42.
6. Connor EM, Sperling RS, Gelber R, et al. Reduction of maternal-infant transmission of human immunodeficiency virus type 1 with zidovudine treatment. Pediatric AIDS Clinical Trials Group Protocol 076 Study Group. N Engl J Med 1994;331:1173–80. http://dx.doi.org/10.1056/NEJM199411033311801
7. Kanshana S, Thewanda D, Teeraratkul A, et al. Implementing short-course zidovudine to reduce mother-infant HIV transmission in a large pilot program in Thailand. AIDS 2000;14:1617–23. http://dx.doi.org/10.1097/00002030-200007280-00018
8. Amornwichet P, Teeraratkul A, Simonds RJ, et al. Preventing mother-to-child HIV transmission: the first year of Thailand's national program. JAMA 2002;288:245–8. http://dx.doi.org/10.1001/jama.288.2.245
9. Plipat T, Naiwatanakul T, Rattanasuporn N, et al. Reduction in mother-to-child transmission of HIV in Thailand, 2001–2003: Results from population-based surveillance in six provinces. AIDS 2007;21:145–51. http://dx.doi.org/10.1097/QAD.0b013e328010e02d
10. Naiwatanakul T, Voramongkol N, Punsuwan N, et al. Uptake of early infant diagnosis in Thailand's national program for preventing mother-to-child HIV transmission and linkage to care, 2008–2011. J Int AIDS Soc 2016;19:20511. http://dx.doi.org/10.7448/IAS.19.1.20511

Influenza Activity — United States, 2015–16 Season and Composition of the 2016–17 Influenza Vaccine

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During the 2015–16 influenza season (October 4, 2015–May 21, 2016) in the United States, influenza activity* was lower and peaked later compared with the previous three seasons (2012–13, 2013–14, and 2014–15). Activity remained low from October 2015 until late December 2015 and peaked in mid-March 2016. During the most recent 18 influenza seasons (including this season), only two other seasons have peaked in March (2011–12 and 2005–06). Overall influenza activity was moderate this season, with a lower percentage of outpatient visits for influenza-like illness (ILI),† lower hospitalization rates, and a lower percentage of deaths attributed to pneumonia and influenza (P&I) compared with the preceding three seasons. Influenza A(H1N1)pdm09 viruses predominated overall, but influenza A(H3N2) viruses were more commonly identified from October to early December, and influenza B viruses were more commonly identified from mid-April through mid-May. The majority of viruses characterized this season were antigenically similar to the reference viruses representing the recommended components of the 2015–16 Northern Hemisphere influenza vaccine (*1*). This report summarizes influenza activity in the United States during the 2015–16 influenza season (October 4, 2015–May 21, 2016)§ and reports the vaccine virus components recommended for the 2016–17 Northern Hemisphere influenza vaccines.

Viral Surveillance

Approximately 350 public health and clinical laboratories in the United States report influenza test results to CDC through either the U.S. World Health Organization (WHO) Collaborating Laboratories System or the National Respiratory and Enteric Virus Surveillance System (NREVSS).¶ During October 4, 2015–May 21, 2016, U.S. WHO participating public health laboratories tested 68,886 specimens for influenza viruses, and 26,538 results were positive; 18,781 (70.8%) were influenza A, and 7,757 (29.2%) were influenza B viruses (Figure 1). Of the 18,437 influenza A viruses subtyped, 14,877 (80.7%) were influenza A(H1N1)pdm09 viruses, and 3,560 (19.3%) were influenza A(H3N2) viruses. Lineage was determined for 4,912 (63.3%) influenza B viruses; 3,367 (68.5%) were B/Yamagata lineage, and 1,545 (31.5%) were B/Victoria lineage.

Clinical laboratories participating in NREVSS tested 639,456 specimens for influenza viruses; 64,921 (10.2%) were positive (Figure 2). Of the positive specimens, 44,201 (68.1%) were influenza A viruses, and 20,720 (31.9%) were influenza B viruses. Based on the percentage of specimens testing positive for influenza, activity peaked during the week ending March 12, 2016 (surveillance week 10), when 23.7% of specimens tested in clinical laboratories were positive for influenza.

Age of the patient was reported for 23,338 (87.9%) of the influenza positive specimens tested by public health laboratories and included 2,657 (11.4%) children aged 0–4 years, 7,062 (30.3%) persons aged 5–24 years, 9,969 (42.7%) persons aged 25–64 years, and 3,650 (15.6%) persons aged ≥65 years. Influenza A(H1N1)pdm09 viruses predominated among all age groups, accounting for approximately half of influenza detections in persons aged 5–24 years and ≥65 years and 69% and 67% among persons aged 0–4 and 25–64 years, respectively. The largest number of influenza A(H3N2) and influenza B viruses were reported among persons aged 5–24 years.

Influenza A(H1N1)pdm09 virus was the most commonly reported influenza virus in all U.S. Department of Health and

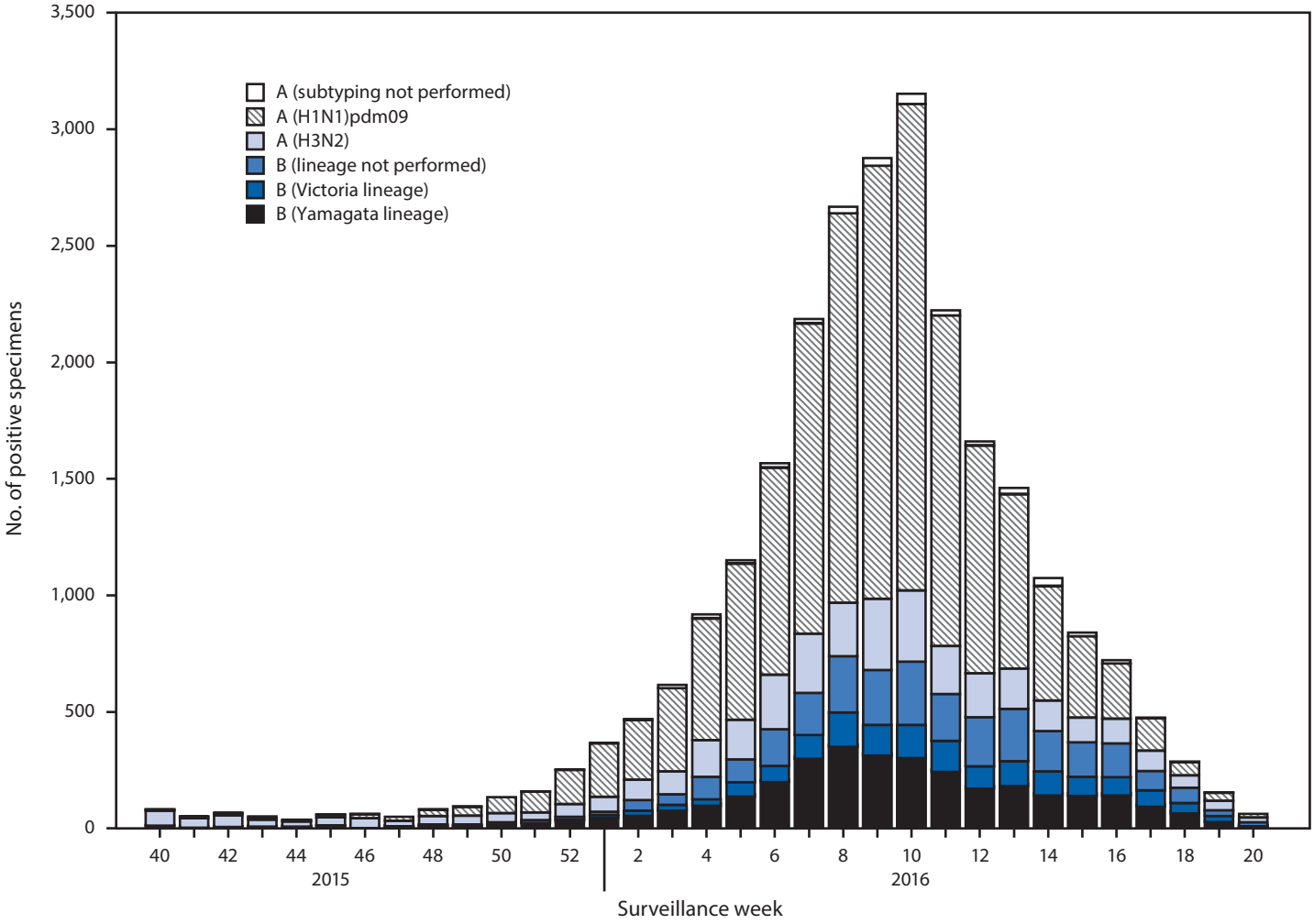
* The CDC influenza surveillance system collects information in five categories from nine data sources: 1) viral surveillance (U.S. World Health Organization collaborating laboratories, the National Respiratory and Enteric Virus Surveillance System, and novel influenza A virus case reporting); 2) outpatient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

† Defined as a temperature of ≥100.0°F (≥37.8°C), oral or equivalent, and cough or sore throat, in the absence of a known cause other than influenza.

§ Data reported as of June 3, 2016.

¶ World Health Organization and National Respiratory and Enteric Virus Surveillance System laboratories include both public health and clinical laboratories located throughout all 50 states, Puerto Rico, and the District of Columbia that contribute to virologic surveillance for influenza. Clinical laboratories test respiratory specimens for diagnostic purposes, whereas public health laboratories primarily test specimens for surveillance purposes. Because of differences in these testing practices, virologic data for clinical and public health laboratories is being presented separately beginning with the 2015–16 influenza season.

FIGURE 1. Number* of influenza positive tests reported to CDC by public health laboratories, by virus subtype/lineage and surveillance week — United States, 2015–16 influenza season†



* N = 25,538.
† Data reported as of June 3, 2016.

Human Services regions**; the proportion of influenza infections from influenza A(H1N1)pdm09 viruses ranged from 75% in Region 5 to 36% in Region 6. Influenza A(H3N2) viruses accounted for approximately 25% of viruses reported in Regions 6 and 9, and influenza B viruses accounted for approximately 43% of viruses reported in Region 10.

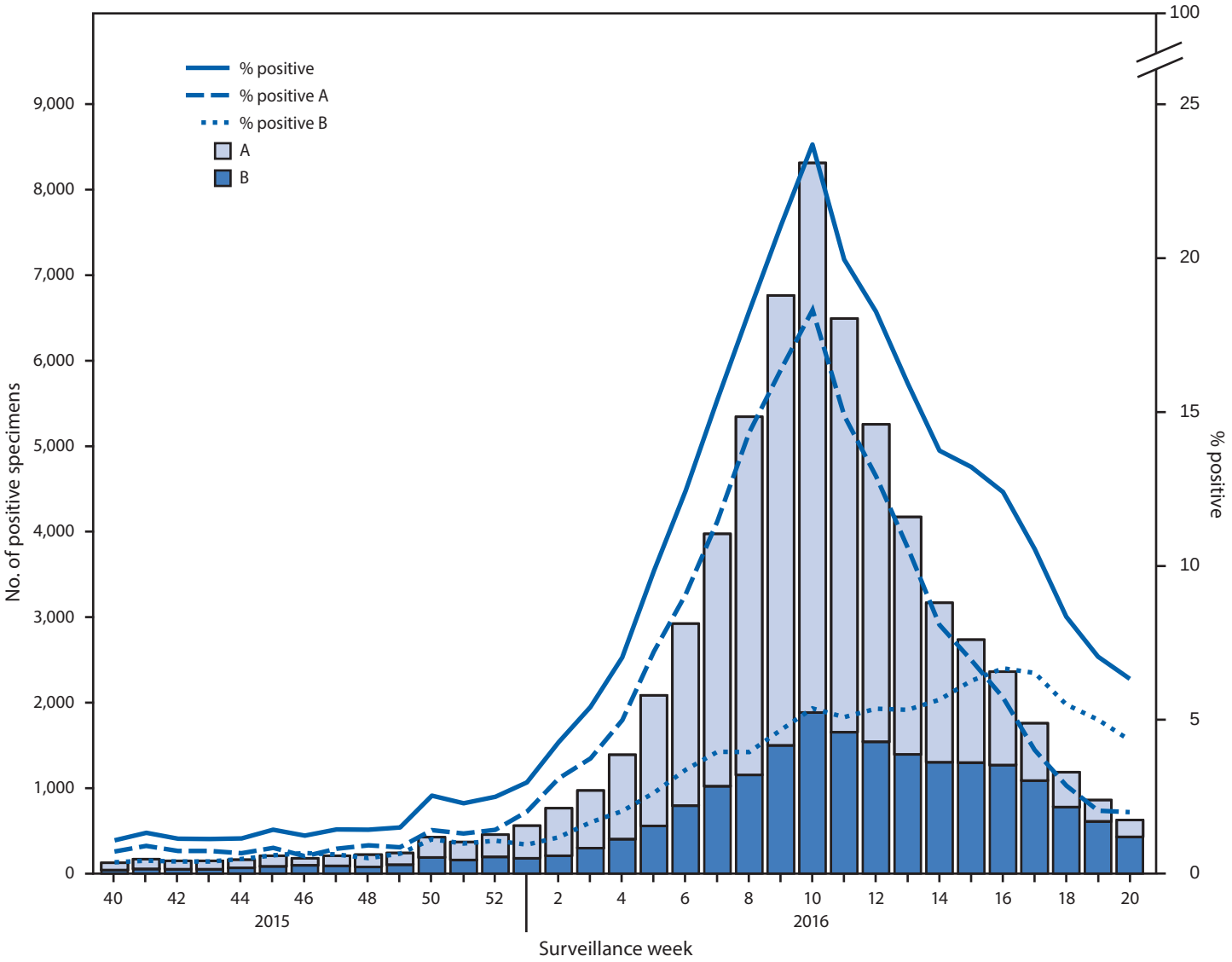
** The 10 regions include the following jurisdictions. *Region 1*: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; *Region 2*: New Jersey, New York, Puerto Rico, and the U.S. Virgin Islands; *Region 3*: Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and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

Novel Influenza A Viruses

During the 2015–16 influenza season, three human infections with novel influenza A viruses were reported to CDC. An influenza A(H1N1) variant (H1N1v) virus†† infection was reported by the Minnesota Department of Health during the week ending December 12, 2015. The patient reported no direct contact with swine in the week before illness onset but lived and worked in an area near where swine were housed. An influenza A(H3N2) variant (H3N2v) virus infection was reported by the New Jersey Department of Health during the week ending January 2,

†† Influenza viruses that circulate in swine are called swine influenza viruses when isolated from swine, but are called variant influenza viruses when isolated from humans. Seasonal influenza viruses that circulate worldwide in human populations have important antigenic and genetic differences from influenza viruses circulating in swine.

FIGURE 2. Number* and percentage of respiratory specimens testing positive for influenza reported by clinical laboratories, by type and surveillance week — United States, 2015–16 influenza season†



* N = 64,921.
† Data reported as of June 3, 2016.

2016, in a patient who reported no direct contact with swine during the week before symptom onset but who had visited a farm where swine were present. Neither of these patients were hospitalized, and both recovered fully. No evidence of human-to-human transmission was identified. An influenza A(H1N2) variant (H1N2v) virus infection was reported by the Minnesota Department of Health during the week ending May 7, 2016, in a patient who was hospitalized as a result of the illness, but who recovered fully. The patient refused to be interviewed during the investigation; therefore, the source of the infection could not be determined.

Antigenic and Genetic Characterization of Influenza Viruses

WHO collaborating laboratories in the United States are requested to submit a subset of their influenza-positive respiratory specimens to CDC for further virus characterization. CDC characterizes influenza viruses through one or more laboratory tests, including genome sequencing, hemagglutination inhibition, and neutralization assays. These data are used to monitor circulating influenza viruses for early identification of viruses that are antigenically different from the recommended influenza vaccine reference viruses. Most viruses analyzed are propagated in mammalian cell cultures because viruses propagated in tissue culture

better represent viruses in circulation, and isolation rates of human influenza viruses are higher in mammalian cell cultures than in eggs, which is the substrate used for production of the majority of influenza vaccines (*2*,*3*). In addition, viruses are more likely to undergo adaptive changes when propagated in eggs. Antigenic and genetic characterization of circulating viruses is performed using both mammalian cell- and egg-propagated reference viruses.

Data obtained from antigenic characterization continue to be important in the assessment of the similarity between reference viruses and circulating viruses. Although vaccine effectiveness field studies must be conducted to determine how well a vaccine is working, these laboratory data are used to evaluate whether changes in the virus that could affect vaccine effectiveness might have occurred. Beginning with the 2014–15 season, a proportion of influenza A(H3N2) viruses have not yielded sufficient hemagglutination titers for antigenic characterization by hemagglutination inhibition. For nearly all viruses characterized at CDC laboratories, next-generation whole genome sequencing is performed to determine the genetic identity of circulating viruses. For the subset of viruses that do not yield sufficient hemagglutination titers, antigenic properties are inferred using results obtained from viruses within the same genetic group as those that have been characterized antigenically.

CDC has antigenically or genetically characterized 2,616 influenza viruses collected and submitted by U.S. laboratories since October 1, 2015, including 997 influenza A(H1N1) pdm09 viruses, 625 influenza A(H3N2) viruses, and 994 influenza B viruses. Among the 997 influenza A(H1N1) pdm09 viruses characterized, 996 (99.9%) were found to be antigenically similar to A/California/7/2009, the reference virus representing the influenza A(H1N1) component of the 2015–16 Northern Hemisphere influenza vaccine. One (0.1%) of the A(H1N1)pdm09 viruses tested showed a reduced titer to A/California/7/2009. Although all recent influenza A(H1N1) pdm09 viruses belong to hemagglutinin (HA) genetic group 6B, two genetic subgroups, 6B.1 and 6B.2, have emerged, with the majority of U.S. viruses belonging to 6B.1. To date, however, viruses from these genetic subgroups remain antigenically similar to the A/California/7/2009 virus component in the vaccine.

All 625 influenza A(H3N2) viruses were genetically sequenced, and all viruses belonged to genetic groups for which a majority of viruses antigenically characterized were similar to cell-propagated A/Switzerland/9715293/2013, the reference virus representing the influenza A(H3N2) component of the 2015–16 Northern Hemisphere vaccine. A subset of 318 influenza A(H3N2) viruses also was antigenically characterized; 309 of 318 (97.2%) were similar to A/Switzerland/9715293/2013.

A total of 548 influenza B/Yamagata-lineage viruses were characterized, and all were found to be similar to B/Phuket/3073/2013, the reference virus representing the influenza B/Yamagata-lineage component of the 2015–16 Northern Hemisphere trivalent and quadrivalent vaccines. A total of 446 influenza B/Victoria-lineage viruses were characterized, and 439 (98.4%) were found to be similar to B/Brisbane/60/2008, the reference virus representing the influenza B/Victoria-lineage component of the 2015–16 Northern Hemisphere quadrivalent vaccine. Seven (1.6%) of the B/Victoria-lineage viruses tested showed reduced titers to B/Brisbane/60/2008.

Antiviral Susceptibility of Influenza Viruses

Since October 1, 2015, a total of 2,408 influenza virus specimens have been tested for susceptibility to influenza antiviral medications. All 1,188 influenza B viruses and 658 influenza A(H3N2) viruses tested were susceptible to oseltamivir, zanamivir, and peramivir. Among 2,193 influenza A(H1N1)pdm09 viruses tested for susceptibility, 18 (0.8%) were found to be resistant to oseltamivir and peramivir. All 1,127 influenza A(H1N1)pdm09 viruses tested were susceptible to zanamivir. High levels of resistance to the adamantanes (amantadine and rimantadine) persist among influenza A viruses currently circulating globally; adamantanes are not effective against influenza B viruses. Adamantane drugs are not recommended for use against influenza at this time.

Composition of the 2016–17 Influenza Vaccine

The Food and Drug Administration's Vaccines and Related Biological Products Advisory Committee has recommended that the 2016–17 influenza trivalent vaccines used in the United States contain an A/California/7/2009 (H1N1)pdm09-like virus, an A/Hong Kong/4801/2014 (H3N2)-like virus, and a B/Brisbane/60/2008-like virus (B/Victoria lineage). It is recommended that quadrivalent vaccines, which have two influenza B viruses, contain the viruses recommended for the trivalent vaccines, as well as a B/Phuket/3073/2013-like virus (B/Yamagata lineage) (*4*). This represents a change in the influenza A(H3N2) component and a change in the influenza B lineage included in the trivalent vaccine compared with the composition of the 2015–16 influenza vaccines. The vaccine viruses recommended for inclusion in the 2016–17 Northern Hemisphere influenza vaccines are the same vaccine viruses that were chosen for inclusion in 2016 Southern Hemisphere seasonal influenza vaccines. These vaccine recommendations were based on a number of factors, including global influenza virologic and epidemiologic surveillance, genetic and antigenic characterization, antiviral susceptibility, and the availability of candidate vaccine viruses for production.

Outpatient Illness Surveillance

Nationally, the weekly percentage of outpatient visits for ILI to health care providers participating in the U.S. Outpatient

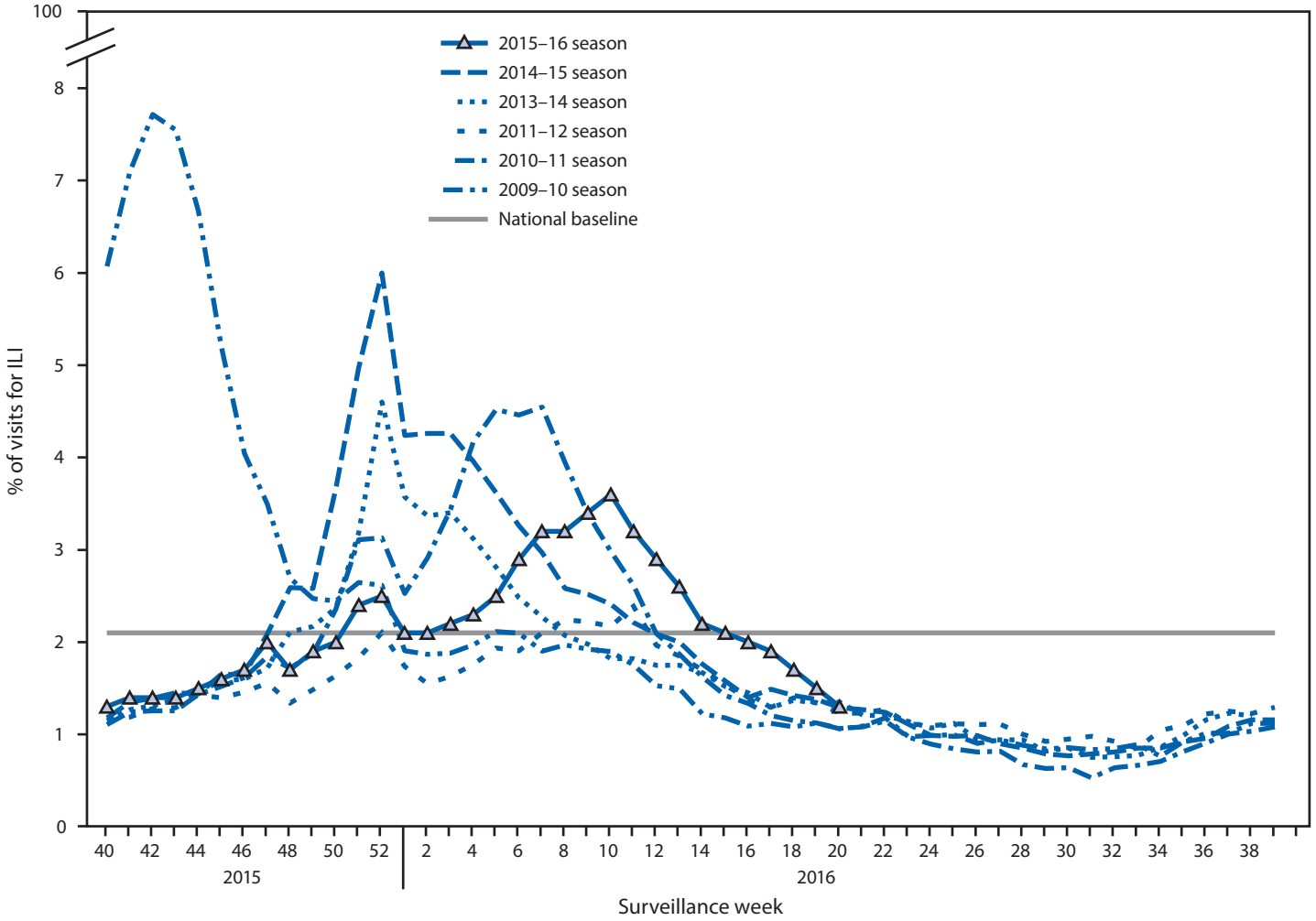
Influenza-Like Illness Surveillance Network (ILINet) exceeded the national baseline level[§§] of 2.1% beginning the week ending December 26, 2015 (week 51) and remained at or above baseline for 17 consecutive weeks during the 2015–16 influenza season (Figure 3). The increase in the percentage of patient visits for ILI during weeks 51 and 52 (the weeks ending December 26, 2015, and January 2, 2016) might have been influenced in part by a reduction in routine health care visits during the holidays, as has occurred during previous seasons. The peak percentage of outpatient visits for ILI was 3.6% and occurred during the week ending March 12, 2016 (week 10). During the 2001–02 through 2014–15 seasons, peak weekly percentages of outpatient visits for ILI ranged from 2.4% to 7.7% and remained at or above baseline levels for an average of 13 weeks (range = 1–20 weeks).

ILINet data are used to produce a weekly jurisdiction-level measure of ILI activity,[¶¶] ranging from minimal to high. The number of jurisdictions experiencing elevated ILI activity

[§§] The national and regional baselines are the mean percentage of visits for ILI during weeks with little or no influenza virus circulation (noninfluenza weeks) for the previous three seasons plus two standard deviations. Noninfluenza weeks are defined as periods of ≥2 consecutive weeks in which each week accounted for <2% of the season's total number of specimens that tested positive for influenza. National and regional percentages of patient visits for ILI are weighted on the basis of state population. Use of the national baseline for regional data is not appropriate.

[¶¶] Activity levels are based on the percentage of outpatient visits in a jurisdiction attributed to ILI and are compared with the average percentage of ILI outpatient visits that occur during weeks with little or no influenza virus circulation. Activity levels range from minimal, which corresponds to ILI activity from outpatient clinics being at or below the average, to high, which corresponds to ILI activity from outpatient clinics being much higher than the average. Because the clinical definition of ILI is nonspecific, not all ILI is caused by influenza; however, when combined with laboratory data, the information on ILI activity provides a clearer picture of influenza activity in the United States.

FIGURE 3. Percentage of visits for influenza-like illness (ILI)* reported to CDC — U.S. Outpatient Influenza-Like Illness Surveillance Network, United States, 2015–16 influenza season and selected previous seasons†



* Defined as a temperature of ≥100.0°F (≥37.8°C), oral or equivalent, and cough or sore throat, in the absence of a known cause other than influenza.
† Data reported as of June 3, 2016.

peaked during the week ending March 12, 2016 (week 10) when a total of 14 states, Puerto Rico, and New York City experienced high ILI activity. A total of 23 jurisdictions experienced high ILI activity during at least 1 week this season. The peak number of jurisdictions experiencing high ILI activity in a single week during the last six influenza seasons has ranged from four during the 2011–12 season to 45 during the 2014–15 season.

Geographic Spread of Influenza Activity

State and territorial epidemiologists report the geographic distribution of influenza in their jurisdictions through a weekly influenza activity code.*** The geographic distribution of influenza activity was most extensive during the week ending March 12, 2016 (week 10), when a total of 41 jurisdictions reported influenza activity as widespread. During the previous six seasons, the peak number of jurisdictions reporting widespread activity ranged from 20 during the 2011–12 season to 49 during the 2010–11 season.

Influenza-Associated Hospitalizations

CDC monitors hospitalizations associated with laboratory-confirmed influenza virus infections using the FluSurv-NET††† surveillance system. Cumulative hospitalization rates per 100,000 population were calculated by age group based on 8,646 total hospitalizations resulting from influenza during October 1, 2015–April 30, 2016. The cumulative incidence§§§ for all age groups was 31.3 per 100,000 population. The cumulative hospitalization rates by age group for this period were 41.8 (0–4 years), 9.7 (5–17 years), 16.8 (18–49 years), 45.2 (50–64 years), and 84.8 (≥65 years) (Figure 4). During the past five influenza seasons, age-specific hospitalization rates ranged from 16.0 to 67.0 (0–4 years), 4.0 to 16.6 (5–17 years), 4.1 to 21.4 (18–49 years), 8.1 to 53.7 (50–64 years), and 30.2 to 308.5 (≥65 years).

Among all hospitalizations, 6,462 (74.5%) were associated with influenza A, 2,131 (24.6%) with influenza B, and 45 (0.5%) with influenza A and B coinfection; 37 (0.4%) had no virus type information. Among those with influenza A subtype information, 2,441 (88.7%) were influenza A(H1N1)pdm09, and 310 (11.3%) were influenza A(H3N2) virus.

Among cases reported as of June 3, 2016, of FluSurv-NET adult patients for whom medical chart data were available, 91.8% had at least one reported underlying medical condition; the most frequently reported underlying conditions were obesity (41.8%), cardiovascular disease (39.6%), and metabolic disorders (38.4%). Among children hospitalized with laboratory-confirmed influenza and for whom medical chart data were available, 47.5% had at least one underlying medical condition. The most commonly reported underlying medical conditions were asthma or reactive airway disease (21.7%) and neurologic disorders (18.3%). Among the 377 hospitalized women of childbearing age (15–44 years) who had laboratory-confirmed influenza, 83 (22.0%) were pregnant.

Pneumonia and Influenza-Associated Mortality

During the 2015–16 influenza season, based on data from CDC's National Center for Health Statistics Mortality Surveillance System,¶¶¶ the proportion of deaths attributed to

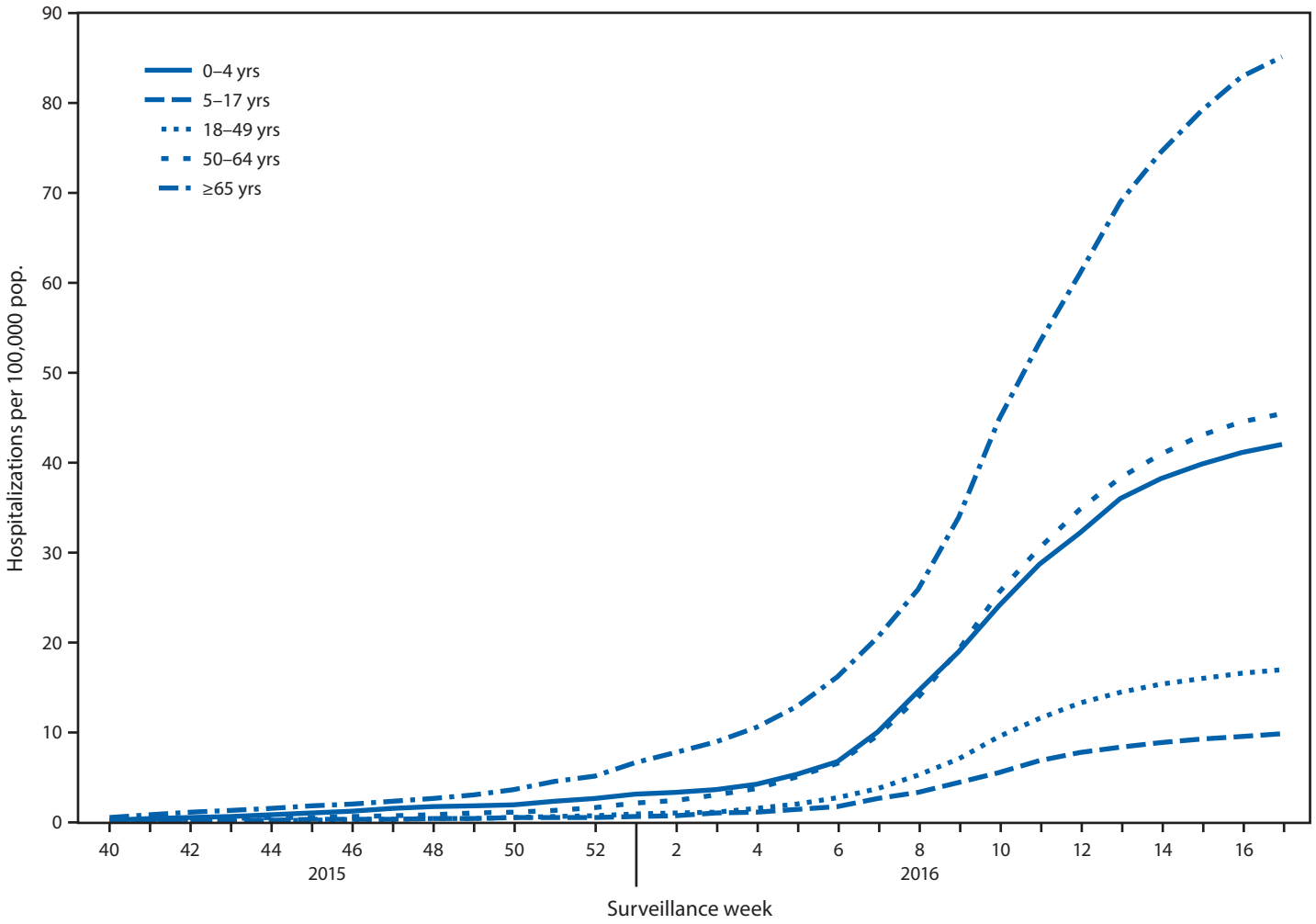
*** Levels of activity are 1) no activity; 2) sporadic: isolated laboratory-confirmed influenza cases or a laboratory-confirmed outbreak in one institution, with no increase in activity; 3) local: increased ILI, or two or more institutional outbreaks (ILI or laboratory-confirmed influenza) in one region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

††† FluSurv-NET conducts population-based surveillance for laboratory-confirmed influenza-associated hospitalizations among children aged <18 years (since the 2003–04 influenza season) and adults aged ≥18 years (since the 2005–06 influenza season). FluSurv-NET covers approximately 70 counties in the 10 Emerging Infections Program states (California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon, and Tennessee) and additional Influenza Hospitalization Surveillance Project (IHSP) states. IHSP began during the 2009–10 season to enhance surveillance during the 2009 H1N1 pandemic. IHSP sites included Idaho, Iowa, Michigan, Oklahoma, and South Dakota during the 2009–10 season; Idaho, Michigan, Ohio, Oklahoma, Rhode Island, and Utah during the 2010–11 season; Michigan, Ohio, Rhode Island, and Utah during the 2011–12 season; Iowa, Michigan, Ohio, Rhode Island, and Utah during the 2012–13 season; and Michigan, Ohio, and Utah during the 2013–14, 2014–15, and 2015–16 seasons.

§§§ Incidence rates are calculated using CDC's National Center for Health Statistics population estimates for the counties included in the surveillance catchment area. Laboratory confirmation is dependent on clinician-ordered influenza testing, and testing for influenza often is underutilized because of the poor reliability of rapid influenza diagnostic test results and greater reliance on clinical diagnosis for influenza. As a consequence, the number of cases identified as part of influenza hospitalization surveillance likely is an underestimate of the actual number of persons hospitalized with influenza.

¶¶¶ Pneumonia and influenza (P&I)–associated deaths are tracked through two systems, the National Center for Health Statistics (NCHS) Mortality Surveillance System, which reports the week the death occurred, and the 122 Cities Mortality Reporting System, which reports the week that the death certificate was registered. Because of these differences in reporting, the two data sources produce different percentages. Beginning with the 2015–16 influenza season, the NCHS Mortality Surveillance System has been the principal component of the U.S. Mortality Surveillance System.

FIGURE 4. Cumulative rates of hospitalization for laboratory-confirmed influenza, by age group and surveillance week — FluSurv-NET,* United States, 2015–16 influenza season†



* FluSurv-NET conducts population-based surveillance for laboratory-confirmed influenza-associated hospitalizations among children aged <18 years (since the 2003–04 influenza season) and adults aged ≥18 years (since the 2005–06 influenza season). FluSurv-NET covers approximately 70 counties in the 10 Emerging Infections Program states (California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon, and Tennessee) and additional Influenza Hospitalization Surveillance Project (IHSP) states. IHSP began during the 2009–10 season to enhance surveillance during the 2009 H1N1 pandemic. IHSP sites included Idaho, Iowa, Michigan, Oklahoma, and South Dakota during the 2009–10 season; Idaho, Michigan, Ohio, Oklahoma, Rhode Island, and Utah during the 2010–11 season; Michigan, Ohio, Rhode Island, and Utah during the 2011–12 season; Iowa, Michigan, Ohio, Rhode Island, and Utah during the 2012–13 season; and Michigan, Ohio, and Utah during the 2013–14, 2014–15, and 2015–16 seasons.
† Data reported as of June 3, 2016.

P&I was at or slightly above the epidemic threshold**** for 3 consecutive weeks from the week ending January 2, 2016, through the week ending January 16, 2016 (weeks 52–2) and again for 4 consecutive weeks from the week ending February 27, 2016, through the week ending March 19, 2016 (weeks 8–11). The percentage of deaths attributed to P&I peaked at 7.9% during the week ending March 19, 2016 (week 11). During the past five influenza seasons, peak weekly percentages of deaths attributable to P&I have ranged from 8.7% during the 2011–12 season to 11.1% during the 2012–13 season.

Based on 122 Cities Mortality Reporting System data, the weekly percentage of deaths attributed to P&I exceeded the

**** The seasonal baseline proportion of P&I deaths is projected using a robust regression procedure, in which a periodic regression model is applied to the observed percentage of deaths from P&I that were reported by the National Center for Health Statistics Mortality Surveillance System and the 122 Cities Mortality Reporting System during the preceding 5 years. The epidemic threshold is set at 1.645 standard deviations above the seasonal baseline. Users of the data should not expect the NCHS mortality surveillance data and the 122 Cities Mortality Reporting System to produce the same percentages, and the percent P&I deaths from each system should be compared with the corresponding system specific baselines and thresholds.

epidemic threshold for the weeks ending January 16, 2016 (week 2) and February 27, 2016 (week 8), and again for 5 consecutive weeks from the week ending March 19, 2016, through the week ending April 16, 2016 (weeks 11–15), and finally, for 2 consecutive weeks from the week ending May 7, 2016, through the week ending May 14, 2016 (weeks 18–19). P&I mortality peaked at 7.8% during the week ending March 26, 2016 (week 12). During the past five influenza seasons, peak weekly percentages of deaths attributable to P&I have ranged from 7.9% during the 2011–12 season to 9.9% during the 2012–13 season.

Influenza-Associated Pediatric Mortality

For the 2015–16 influenza season, as of June 3, 2016, a total of 74 laboratory-confirmed, influenza-associated pediatric deaths had been reported from Puerto Rico, the District of Columbia, and 31 states. The deaths occurred in children aged 2 months–16 years; mean and median ages were 7.0 years and 6.0 years, respectively. Among the 74 deaths, 29 were associated with an influenza A (H1N1)pdm09 virus infection, three were associated with an influenza A(H3N2) virus infection, 17 were associated with an influenza A virus infection for which no subtyping was performed, 23 were associated with an influenza B virus infection, and two were associated with an influenza virus infection for which type was not determined.

Since influenza-associated pediatric mortality became a nationally notifiable condition in 2004, the total number of influenza-associated pediatric deaths has ranged from 37 to 171 per season; this excludes the 2009 pandemic, when 358 pediatric deaths occurring during April 15, 2009–October 2, 2010 were reported to CDC. The number of influenza-associated pediatric deaths reported during the 2015–16 influenza season was lower than the number reported for each of the three preceding influenza seasons (171 in 2012–13, 111 in 2013–14, and 148 in 2014–15).

Summary

What is already known about this topic?

CDC collects, compiles, and analyzes data on influenza activity year-round in the United States. Substantial influenza activity generally begins in the fall and continues through the winter and spring months. However, the timing and severity of influenza activity varies by geographic location and season.

What is added by this report?

The 2015–16 influenza season was less severe overall compared with the preceding three seasons. The cumulative hospitalization rate for all ages of 31.3 per 100,000 population was lower than those for the previous three seasons (64.1 in 2014–15, 35.1 in 2013–14, and 44.0 in 2012–13), and the number of influenza-associated pediatric deaths (74) also was lower compared with previous seasons (148 in 2014–15, 111 in 2013–14, and 171 in 2012–13). Influenza activity began later and continued for a longer period, peaking in mid-March. During the most recent 18 influenza seasons, only two other seasons have peaked in March (2011–12 and 2005–06). Influenza A (H1N1)pdm09 viruses predominated during the 2015–16 influenza season, with influenza B viruses, and to a lesser extent, influenza A (H3N2) viruses cocirculating. Antigenic and genetic characterization showed that most circulating viruses were well-matched to the 2015–16 Northern Hemisphere vaccine.

What are the implications for public health practice?

Influenza surveillance, including for novel influenza viruses, should continue throughout the summer months, and health care providers should consider influenza as a cause of respiratory illness even outside the typical season. Although influenza viruses typically circulate at low levels during the summer months, antiviral treatment is recommended for all patients with confirmed or suspected influenza who have severe, complicated, or progressive influenza-like illness; those who require hospitalization; and those at higher risk for influenza-related complications, including adults aged ≥65 years. These medications work best when administered early in the course of illness.

Discussion

The 2015–16 influenza season peaked in mid-March, somewhat later than usual. Influenza A(H1N1)pdm09 viruses predominated overall, but influenza A(H3N2) and influenza B viruses also circulated. The season was less severe overall compared with the preceding three seasons, including 2013–14, the last influenza season when influenza A(H1N1)pdm09 was the predominant virus. Whereas influenza A(H3N2)–predominant seasons are typically more severe overall than influenza A(H1N1)pdm09–predominant seasons, and are especially severe among the elderly and the very young, influenza A(H1N1)pdm09 viruses have been associated with severe illness in younger adults since the virus emerged during the 2009 pandemic, when mortality rates were highest in adults aged 50–64 years, and again during the 2013–14 season, when adults aged <65 years were at high risk for severe influenza illness (*5*). For this season, and the 2013–14 season, cumulative hospitalization rates for adults aged 50–64 years were 45.2 and 53.7 per 100,000 population, respectively, demonstrating that although some age groups are at high risk for developing influenza-related complications every year (*6*), influenza can cause severe illness in persons of any age, including adults aged 50–64 years.

Testing for seasonal influenza viruses and monitoring for novel influenza A virus infections should continue throughout the summer. Although summer influenza activity in the United States typically is low, influenza cases and outbreaks have occurred during summer months, and clinicians should remain vigilant in considering influenza in the differential diagnosis of summer respiratory illnesses. Health care providers

also are reminded to consider novel influenza virus infections in persons with ILI, with swine or poultry exposure, or with severe acute respiratory infection after travel to areas where avian influenza viruses have been detected, especially if there was recent close contact with animals such as wild birds, poultry, or pigs. Providers should alert the local and state public health department if a human infection with a novel influenza virus infection is suspected.

Although vaccination is the best method for preventing and reducing the impact of influenza, prompt treatment with influenza antiviral medications remains an important adjunct for lessening both the severity and duration of influenza (*7*–*9*). Patients with confirmed or suspected influenza who have severe illness, require hospitalization, or are at high risk for influenza-related complications should be treated with antivirals as soon as possible. Treatment of severely ill patients or those at high risk should not be delayed or withheld pending confirmatory influenza test results because early treatment is most effective and rapid antigen detection influenza diagnostic tests can be insensitive (*7*–*9*).

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

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References

1. Russell K, Blanton L, Kniss K, et al. Update: influenza activity—United States, October 4, 2015–February 6, 2016. MMWR Morb Mortal Wkly Rep 2016;65:146–53. http://dx.doi.org/10.15585/mmwr.mm6506a3
2. Schild GC, Oxford JS, de Jong JC, Webster RG. Evidence for host-cell selection of influenza virus antigenic variants. Nature 1983;303:706–9. http://dx.doi.org/10.1038/303706a0
3. Katz JM, Wang M, Webster RG. Direct sequencing of the HA gene of influenza (H3N2) virus in original clinical samples reveals sequence identity with mammalian cell-grown virus. J Virol 1990;64:1808–11.
4. Food and Drug Administration. Summary minutes: meeting of the Vaccines and Related Biological Products Advisory Committee. Silver Spring, MD: US Department of Health and Human Services, Food and Drug Administration; 2016. http://www.fda.gov/downloads/AdvisoryCommittees/CommitteesMeetingMaterials/BloodVaccinesandOtherBiologics/accinesandRelatedBiologicalProductsAdvisoryCommittee/UCM494071.pdf
5. Epperson S, Blanton L, Kniss K, et al. Influenza activity—United States, 2013–14 season and composition of the 2014–15 influenza vaccines. MMWR Morb Mortal Wkly Rep 2014;63:483–90.
6. Grohskopf LA, Sokolow LZ, Olsen SJ, Bresee JS, Broder KR, Karron RA. Prevention and control of influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices—United States, 2015–16 influenza season. MMWR Morb Mortal Wkly Rep 2015;64:818–25. http://dx.doi.org/10.15585/mmwr.mm6430a3
7. Fiore AE, Fry A, Shay D, Gubareva L, Bresee JS, Uyeki TM. Antiviral agents for the treatment and chemoprophylaxis of influenza—recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2011;60(No. RR-1).
8. Dobson J, Whitley RJ, Pocock S, Monto AS. Oseltamivir treatment for influenza in adults: a meta-analysis of randomised controlled trials. Lancet 2015;385:1729–37. http://dx.doi.org/10.1016/S0140-6736(14)62449-1
9. CDC. Why CDC recommends influenza antiviral drugs. Atlanta, GA: US Department of Health and Human Services, CDC; 2015. http://www.cdc.gov/media/haveyouheard/hyh-antiviraldrugs.html

Vital Signs: Deficiencies in Environmental Control Identified in Outbreaks of Legionnaires' Disease — North America, 2000–2014

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Abstract

Background: The number of reported cases of Legionnaires' disease, a severe pneumonia caused by the bacterium *Legionella*, is increasing in the United States. During 2000–2014, the rate of reported legionellosis cases increased from 0.42 to 1.62 per 100,000 persons; 4% of reported cases were outbreak-associated. *Legionella* is transmitted through aerosolization of contaminated water. A new industry standard for prevention of *Legionella* growth and transmission in water systems in buildings was published in 2015. CDC investigated outbreaks of Legionnaires' disease to identify gaps in building water system maintenance and guide prevention efforts.

Methods: Information from summaries of CDC Legionnaires' disease outbreak investigations during 2000–2014 was systematically abstracted, and water system maintenance deficiencies from land-based investigations were categorized as process failures, human errors, equipment failures, or unmanaged external changes.

Results: During 2000–2014, CDC participated in 38 field investigations of Legionnaires' disease. Among 27 land-based outbreaks, the median number of cases was 10 (range = 3–82) and median outbreak case fatality rate was 7% (range = 0%–80%). Sufficient information to evaluate maintenance deficiencies was available for 23 (85%) investigations. Of these, all had at least one deficiency; 11 (48%) had deficiencies in ≥2 categories. Fifteen cases (65%) were linked to process failures, 12 (52%) to human errors, eight (35%) to equipment failures, and eight (35%) to unmanaged external changes.

Conclusions and Implications for Public Health Practice: Multiple common preventable maintenance deficiencies were identified in association with disease outbreaks, highlighting the importance of comprehensive water management programs for water systems in buildings. Properly implemented programs, as described in the new industry standard, could reduce *Legionella* growth and transmission, preventing Legionnaires' disease outbreaks and reducing disease.

Introduction

Legionnaires' disease, a severe, sometimes fatal pneumonia, can occur in persons who inhale aerosolized droplets of water contaminated with the bacterium *Legionella*. Exposure to *Legionella* in freshwater environments such as lakes and streams does not lead to disease; however, in manmade water systems, *Legionella* can grow and spread to susceptible hosts, including persons aged ≥50 years, smokers, and persons with underlying medical conditions such as chronic lung disease or immunosuppression.

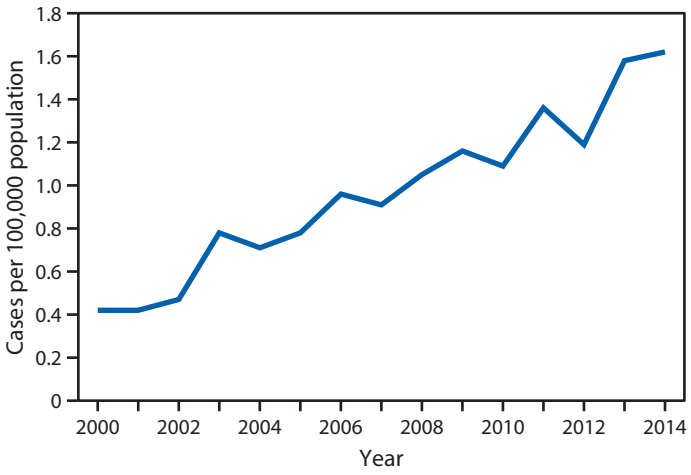
CDC investigated the first outbreak of Legionnaires' disease in 1976. Currently, approximately 5,000 cases of Legionnaires' disease are reported to CDC each year; however, Legionnaires' disease might be underdiagnosed. During 2000–2014, the rate of reported cases of legionellosis, which comprises both Legionnaires' disease and Pontiac fever, a milder, self-limited, influenza-like illness, increased 286%, from 0.42 to 1.62 cases per 100,000 persons in the United States (*1*,*2*) (Figure 1). The reason for this increase is unknown but is likely multifactorial. The higher rates could represent a true increase in the frequency of disease related to several factors, such as a greater number of persons at risk for legionellosis because of underlying illness or immunocompromising medications, an aging U.S. population, aging plumbing infrastructure, or changes in the climate. Increased use of diagnostic testing because of greater awareness among clinicians and availability of diagnostic tests, as well as more reliable reporting to local and state health departments and CDC could also be playing a role. Approximately 9% of cases are fatal (*3*). Among 32 potable water–associated outbreaks reported in the United States during 2011–2012, legionellosis was implicated in 21 (66%) outbreaks and all 14 deaths (*4*). During 2000–2012, CDC's Waterborne Disease and Outbreak Surveillance System received reports of approximately 160 legionellosis outbreaks (*5*).

Key Points

- Legionnaires' disease is a lung infection that is fatal for about one in 10 persons who become infected. *Legionella*, the bacterium that causes Legionnaires' disease, grows well in warm water, but can be killed by disinfectants, such as chlorine. Persons can get Legionnaires' disease when they breathe in small droplets of water contaminated with *Legionella*.
- Persons most likely to get Legionnaires' disease are those aged ≥50 years, smokers, and persons with underlying medical conditions, such as chronic lung disease or weakened immune systems.
- *Legionella* grows best in building water systems that are not well maintained, especially where levels of chlorine or other disinfectants are low and water temperatures are optimal for its growth. Legionnaires' disease outbreaks most often occur in hotels, long-term care facilities, and hospitals. The most common sources are potable water (e.g., drinkable water used for showering), cooling towers, hot tubs, and decorative fountains.
- The key to preventing outbreaks is good management of building water systems, according to new industry standards. Outbreaks have occurred because of process failures (65%), human errors (52%), equipment failures (35%), external conditions (35%), or a combination of these (48%). Building owners and managers should determine if their building water systems are at increased risk for *Legionella* growth and spread. If so, they should develop and use a *Legionella* water management program according to the new industry standards (http://www.cdc.gov/legionella/WMPtoolkit).
- Additional information is available at http://www.cdc.gov/vitalsigns.

Legionnaires' disease outbreak investigations require an environmental assessment to identify potential sources of exposure. Environmental assessments are rarely conducted for Legionnaires' disease cases that are not recognized as part of an outbreak; therefore, most of what is known about *Legionella* transmission has been learned from outbreak investigations. During 2005–2009, only 4% of confirmed legionellosis cases reported among U.S. residents were associated with a known outbreak or cluster (*6*), although some sporadic cases were likely associated with unrecognized outbreaks or clusters. Identified outbreaks generally are linked to environmental

FIGURE 1. Reported cases of legionellosis per 100,000 population, by year — United States, 2000–2014



reservoirs in large or complex water systems,* such as those found in hotels or resorts, hospitals, long-term care facilities, and cruise ships. Transmission from these water systems to humans requires aerosol generation, as can occur from showerheads, cooling towers, hot tubs, and decorative fountains (*7*). Only one case of possible person-to-person transmission has been reported (*8*). Legionnaires' disease is typically diagnosed by a *Legionella* urinary antigen test or culture of lower respiratory secretions using selective media; epidemiologic links to environmental sources can be confirmed when isolates from clinical and environmental specimens match by molecular typing (*9*). One species, *Legionella pneumophila*, accounts for approximately 90% of reported legionellosis cases in the United States (*7*).

Because *Legionella* transmission occurs from manmade environmental settings, the most effective strategy for prevention of Legionnaires' disease is through control of *Legionella* in water systems in buildings. In 2015, ASHRAE (formerly known as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers) published a consensus standard for the primary prevention of Legionnaires' disease (*10*), which calls for the development and implementation of water management programs in large or complex water systems in buildings. The standard, which is based on best practices, focuses on identifying hazardous conditions and applying control measures to interrupt *Legionella* growth and transmission.

Outbreak investigations often find manmade water systems with maintenance gaps that permit the growth of *Legionella*.

* Large or complex water systems, where *Legionella* can grow and spread, are most often associated with commercial, institutional, multiunit residential, health care, and industrial buildings, often with multiple stories and complicated plumbing systems. Buildings in which vulnerable populations, such as immunocompromised or elderly persons, live or are treated are also considered to have complex water systems.

To identify opportunities for prevention, summaries of all CDC field investigations of outbreaks of Legionnaires' disease during 2000–2014 were reviewed to characterize water system maintenance deficiencies leading to those outbreaks.

Methods

CDC offers assistance to health departments with field investigations of outbreaks of Legionnaires' disease. After each investigation, CDC reviews and summarizes the field notes to understand conditions that led to the outbreak. These summaries highlight the main findings from each investigation, including the numbers of cases and deaths, clinical or environmental strains of *Legionella* identified, potential or confirmed environmental sources, and possible environmental factors that contributed to the outbreak, as well as recommended solutions for the management of current outbreaks and prevention of future outbreaks.

CDC reviewed all investigation summaries and associated publications describing Legionnaires' disease outbreak investigations conducted during 2000–2014. Investigations involving cruise ships were excluded, because their water systems are managed differently from land-based water systems. Two investigators used a standard abstraction form to review the relevant materials. Confirmed and suspected Legionnaires' disease cases were defined using each outbreak's case definitions; thus, slight variations in case definition among outbreaks were possible. Investigation summaries were reviewed to identify possible root causes that could facilitate *Legionella* growth and transmission. Each reviewer independently assigned findings to one or more of four categories: 1) process failures, in which a process, such as a water management program, was missing or inadequate; 2) human errors, in which a person did not perform as expected, such as not replacing hot tub filters according to manufacturer's recommendations; 3) equipment failures, in which a piece of equipment did not operate as expected, such as a malfunctioning disinfectant delivery system; and 4) unmanaged external changes, in which adjustments were not made to account for events outside a building water system, such as nearby construction leading to changes in potable water quality. Discrepant categorizations were resolved through consultation with a third reviewer.

Results

During 2000–2014, CDC participated in 38 field investigations of Legionnaires' disease. Three investigations, determined not to be outbreaks because of lack of sufficient clinical or epidemiologic evidence, were excluded. Eight investigations involving cruise ships, associated with 19 confirmed and 17 suspected cases of Legionnaires' disease, including two deaths, were also excluded. Among the remaining 27 investigations, 24 occurred in U.S. states and territories, two in Mexico, and one in Canada. The most frequent outbreak settings were hotels and resorts (n = 12, 44%), long-term care facilities (5, 19%), and hospitals (4, 15%) (Table 1). The remaining six outbreaks were evenly distributed among senior living facilities (n = 2, 7%), workplaces (2, 7%), and the community (2, 7%). Potable water was the most frequent source of exposure (n = 15, 56%), followed by cooling towers (6, 22%), hot tubs (2, 7%), industrial equipment (1, 4%), and a decorative fountain (1, 4%); for two outbreaks (7%), sources were not identified (Figure 2). Potable water sources accounted for 58% of travel-associated outbreaks (in hotels and resorts) and 67% of health care–associated outbreaks (in hospitals and long-term care facilities).

All 27 outbreaks were caused by *Legionella pneumophila* serogroup 1. Among 13 (48%) investigations (Table 1), links between human cases and water sources were established through DNA-sequence–based typing that identified indistinguishable clinical and environmental isolates. No clinical isolate was available for nine (33%) outbreaks, no environmental isolate was available for one (4%), and neither a clinical nor environmental isolate was available for two (7%); the clinical and environmental isolates did not match for the remaining two (7%) outbreaks. All available outbreak strains reacted with monoclonal antibody 2 of the international *L. pneumophila* serogroup 1 panel, a potential marker of increased virulence (*11*).

The 27 outbreaks included 415 cases, 323 (78%) of which were confirmed[†] and 92 (22%) suspected (Table 1). A median of 10 confirmed and suspected cases occurred in each outbreak (range = 3–82). The median number of cases in cooling tower outbreaks was 22, and in potable water outbreaks was 10. Health care–associated outbreaks accounted for 57% of all 415 cases, with a median of 19 cases per health care–associated outbreak; travel-associated outbreaks accounted for 25% of cases, with a median of seven cases per travel-associated outbreak.

Among confirmed and suspected Legionnaires' disease cases, 65 deaths occurred; the median outbreak case fatality rate was 7% (range = 0%–80%). Health care–associated outbreaks accounted for 85% of deaths (median health care–associated outbreak case fatality rate = 24%, range = 6%–80%); travel-associated outbreaks accounted for 6% of deaths (median travel-associated outbreak case fatality rate = 0%, range = 0%–17%). Patients in seven of the nine health care–associated outbreaks included persons who were employees, visitors, or outpatients who did not stay overnight at the facility. No transplant patients were among the health care–associated cases. In 23 investigations for which the outbreak duration could be determined, the median interval from onset of the

[†] For comparison, an estimated 41,500 cases of confirmed cases of Legionnaires' disease were reported to CDC during 2000–2014 (unpublished data).

TABLE 1. CDC field Investigations of Legionnaires' disease outbreaks — North America, 2000–2014* (n = 27)

Year of investigation	Setting	Source	Environmental and clinical isolate match†	No. confirmed and suspected cases			No. deaths	Case fatality rate (%)
				Total§	Confirmed§	Suspected§		
2001	Workplace	Industrial equipment	No	4	4	0	2	50
2001	Hotel/Resort	Potable water	Yes	21	5	16	1	5
2002	Long-term care facility	Potable water	Yes	31	12	19	2	6
2003	Hotel/Resort	Potable water	No clinical isolate	3	3	0	0	0
2004	Hotel/Resort	Potable water	No clinical isolate	8	7	1	0	0
2004	Hotel/Resort	Hot tub	No environmental or clinical isolate	6	5	1	0	0
2004	Community	Cooling tower	No clinical isolate	9	7	2	2	22
2005	Community	Decorative fountain	Yes	18	18	0	1	6
2005	Long-term care facility	Cooling tower	Yes	82	82	0	23	28
2006	Hospital	Potable water	Yes	10	10	0	3	30
2006	Senior living facility	Potable water	No clinical isolate	6	3	3	0	0
2008	Hotel/Resort	Potable water	Yes	13	11	2	0	0
2009	Senior living facility	Potable water	Yes	10	10	0	1	10
2010	Hotel/Resort	Potable water	Yes	11	10	1	0	0
2010	Hotel/Resort	Cooling tower	Yes	8	6	2	1	13
2010	Workplace	Cooling tower	Yes	29	7	22	0	0
2011	Hospital	Potable water	No clinical isolate	13	3	10	1	8
2011	Hotel/Resort	Unknown¶	No environmental or clinical isolate	3	3	0	0	0
2011	Long-term care facility	Potable water	No clinical isolate	10	4	6	8	80
2011	Hotel/Resort	Potable water	No clinical isolate	5	5	0	0	0
2012	Hospital	Potable water (possibly also decorative fountain)	Yes	21	21	0	5	24
2013	Long-term care facility	Unknown	No	19	15	4	5	26
2013	Hotel/Resort	Cooling tower	No clinical isolate	15	15	0	1	7
2013	Long-term care facility	Cooling tower	Yes	41	39	2	6	15
2013	Hotel/Resort	Hot tub	No environmental isolate	4	3	1	0	0
2014	Hotel/Resort	Potable water (and possibly hot tub)	No clinical isolate	6	6	0	1	17
2014	Hospital	Potable water	Yes	9	9	0	2	22
Total				**415**	**323**	**92**	**65**	**7****

* Excludes one pseudo-outbreak, two non-outbreaks, and eight cruise ship outbreaks.
† On the basis of DNA-sequence–based typing.
§ For the purposes of this analysis, cases of confirmed and suspect Legionnaires' disease were defined using each outbreak's case definition.
¶ Decorative fountain suspected; potable water/hot tub not excluded.
** Median.

first to last cases was 49 days. Median outbreak duration was longer for potable water outbreaks (98 days) than for outbreaks linked to other sources (28 days).

Twenty-three (85%) investigation summaries had sufficient information to evaluate the contribution of deficiencies in water system maintenance to the outbreak (Table 2). The most frequent deficiencies noted were categorized as process failures (n = 15, 65%), followed by human errors (12, 52%), equipment failures (8, 35%), and unmanaged external changes (8, 35%). For 11 (48%) outbreaks, deficiencies in more than one category were reported. Sixteen (70%) investigations reported inadequate water disinfectant levels and 12 (52%) reported water temperatures in the optimal range for *Legionella* growth (*12*).§ Indications of inadequate maintenance of hot tubs and decorative fountains were almost always noted. Among the seven investigations where outbreaks were believed to be associated with unmanaged external changes, nearby construction (n = 3, 43%) and problems with water mains (3, 43%) were most frequently noted. Three buildings had water management programs (all developed before the

§ Although *Legionella* has been recovered from water with temperatures outside this range, the temperature range most favorable for growth of *Legionella* is 25°C–42°C (77°F–108°F). For health care facilities, ASHRAE Guideline 12-2000 recommends storing and distributing cold water at temperatures <20°C (<68°F), whereas hot water should be stored at >60°C (>140°F) and circulated with a minimum return temperature of 51°C (124°F). In other settings, hot water should be stored at ≥49°C (≥120°F).

publication of ASHRAE's standard in 2015); however, the occurrence of outbreaks suggests that the existing water management programs were inadequate (*13*,*14*).

Conclusions and Comments

The number of cases of Legionnaires' disease in the United States is increasing, and associated mortality is substantial. Identifying ways to reduce environmental transmission of *Legionella* is crucial to reducing morbidity and mortality associated with Legionnaires' disease. The new ASHRAE standard establishes minimum requirements for management of the risk for *Legionella* growth and transmission in building water systems. Gaps in maintenance that could be addressed with a water management program to prevent Legionnaires' disease outbreaks were described in 23 (85%) of 27 investigated outbreaks. Outbreaks resulted from a combination of deficiencies, most frequently classified as process failures and human errors. In the majority of outbreaks, inadequate water disinfectant levels and temperatures in the optimal range for *Legionella* growth were observed; implementing a functional water management program could address these deficiencies through routine monitoring of disinfectant levels and water temperature (*10*). Deficiencies related to equipment failures and unmanaged external changes were less common but are also remediable through preventive measures, such as flushing of potable water systems after water main breaks. Although approximately half the outbreaks included in this analysis resulted from multiple deficiencies, approximately half resulted from a single deficiency, suggesting that even a single deficiency can be sufficient to cause an outbreak; thus, all deficiencies should be addressed.

The most frequent outbreak settings in this analysis were hotels and resorts, long-term care facilities, and hospitals. Although 44% of the outbreaks were travel-associated and 33% were health care–associated, health care–associated outbreaks were larger and resulted in more deaths than travel-associated outbreaks. Potable water was the most frequent source of exposure; however, outbreaks related to cooling tower outbreaks were associated with larger numbers of cases. This finding is consistent with the outdoor location of cooling towers and their ability to create plumes of potentially contaminated water that can expose larger numbers of persons than potable water outbreaks. Potable water outbreaks are usually associated with cases among building occupants, such as hospital patients and hotel guests. Hot tubs have been reported to be an important cause of outbreaks in hotels and cruise ships (*15*). Regardless of setting or source, a comprehensive approach to prevention requires an understanding of the mechanisms by which *Legionella* growth and transmission can occur in any building water system. Understanding the nature of deficiencies in water system maintenance using a categorization scheme such as the one described in this report can help inform plans for remediation and prevention following outbreaks of Legionnaires' disease.

Until published by ASHRAE in 2015, consensus recommendations regarding the development of water management programs to reduce transmission of *Legionella* were unavailable; thus, ASHRAE's approach to developing and implementing *Legionella* water management programs for water systems in buildings might be unfamiliar to building owners and managers (*10*). CDC and its partners have developed a toolkit (http://www.cdc.gov/legionella/WMPtoolkit) to facilitate implementation of this new standard. The multistep process begins by determining if a building is at increased risk for growth and transmission of *Legionella*, in which case the formation of a specialized management team is required. The toolkit guides the team through the process of identifying and controlling conditions that can permit *Legionella* growth and transmission in their building water systems. The process requires careful planning, frequent communication, consistent implementation, and regular review. Taking these steps should reduce the risk for *Legionella* growth and transmission.

FIGURE 2. Percentage of outbreaks and cases of Legionnaires' disease, by environmental source — North America, 2000–2014

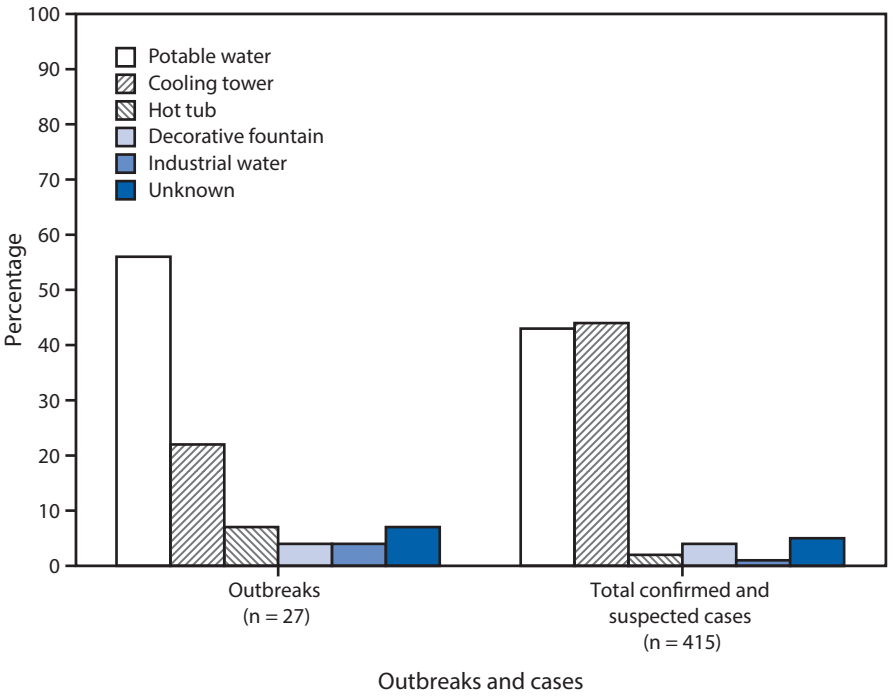


TABLE 2. Deficiencies in water system maintenance contributing to growth and transmission of *Legionella* among outbreaks of Legionnaires' disease investigated by CDC — North America, 2000–2014 (n = 23)

Setting	Source	Deficiency	Category*			
			Process failure	Human error	Equipment failure	Unmanaged external change
Hotel/Resort	Potable water	Temperatures in optimal range for *Legionella* growth† in cold potable water	✓			
Hotel/Resort	Potable water	Temperatures in optimal range for *Legionella* growth† in potable water Inadequate disinfectant in potable water	✓			
Hotel/Resort	Potable water	Temperatures in optimal range for *Legionella* growth† in potable water Inadequate disinfectant in potable water	✓			
Hotel/Resort	Potable water	Temperatures in optimal range for *Legionella* growth† in hot water heaters and in potable water Inadequate disinfectant in potable water, including water coming from supplier Stagnation§ because of large amounts of water storage and closed wing with unused potable water system (because of low occupancy)	✓			
Hotel/Resort	Potable water	Temperatures in optimal range for *Legionella* growth† in both hot and cold potable water Inadequate disinfectant in potable water Water temperature in hot water heater lower than indicated on thermostat	✓		✓	
Hotel/Resort	Potable water	Temperatures in optimal range for *Legionella* growth† in potable water *Legionella* water management program (in place as a result of previous outbreak) not comprehensive (i.e., disinfectant not monitored, and remediation performed on a room-by-room basis at certain action thresholds only) Inadequate disinfectant in potable water because of installation of chlorine dioxide injector before the hot water heaters, and occasional mechanical failures of the disinfectant pumps	✓	✓	✓	
Hotel/Resort	Potable water (and possibly also hot tub)	Temperatures in optimal range for *Legionella* growth† in potable water Lack of disinfectant in potable water (resort served by well water, disinfectant not required by state law) Lack of potable water distribution mapping plans (staff unable to describe system) Poor access to filters and disinfectant feeder because of hot tub placement and equipment design Broken water main¶ (not followed by appropriate flushing of the distribution system)	✓	✓	✓	✓
Hotel/Resort	Hot tub	Inadequate maintenance of hot tub Lack of knowledge by contracted pool operator		✓		
Hotel/Resort	Hot tub	Inadequate disinfectant in hot tub water because of inaccurate disinfectant feeding equipment, resulting in inadequate disinfectant delivery (unrecognized by hot tub operator) Inadequate hot tub maintenance and disinfectant monitoring Unenforced limits on bather loads Improper air circulation because of dysfunctional exhaust vents of dehumidifier in pool room, leading to increased exposure to aerosolized bacteria		✓	✓	
Hotel/Resort	Cooling tower	Inadequate disinfectant in cooling tower because of irregular addition of disinfectant by contractor Inadequate record keeping		✓		

See table footnotes on page 583.

TABLE 2. (*Continued*) Deficiencies in water system maintenance contributing to growth and transmission of *Legionella* among outbreaks of Legionnaires' disease investigated by CDC — North America, 2000–2014 (n = 23)

Setting	Source	Deficiency	Category*			
			Process failure	Human error	Equipment failure	Unmanaged external change
Hotel/Resort	Unknown (suspected to be a decorative fountain, but possibly potable water or hot tub)	Temperatures in optimal range for *Legionella* growth† in potable water Inadequate disinfectant in potable water and hot tubs Disinfectant not routinely added to decorative fountain, inadequate maintenance of decorative fountain suspected (but fountain was hyperchlorinated before testing)	✓	✓		
Hospital	Potable water	Hospital under major construction** at time of outbreak (*Legionella* found in potable water almost exclusively in new building)				✓
Hospital	Potable water	Temperatures in optimal range for *Legionella* growth† at hot water storage tank Inadequate disinfectant in potable water Use of tap water in personal respiratory device Insufficient clinical testing for *Legionella* among patients with pneumonia meeting criteria for possible Legionnaires' disease	✓	✓		
Hospital	Potable water	Existing *Legionella* risk-reduction plan inadequate (*Legionella* consistently found in hospital potable water) Inadequate disinfectant in potable water (documented by hospital and not addressed) Insufficient clinical testing for *Legionella* among patients with health care–associated pneumonia Failure of hospital to implement water restrictions upon detecting contamination with *Legionella* in potable water and associated cases of Legionnaires' disease Failure of hospital to notify public health officials of a recognized outbreak of Legionnaires' disease Stagnation§ following plumbing inspection and flushing 2 months before occupation of new hematology-oncology unit	✓	✓		✓
Hospital	Potable water (and possibly also decorative fountain)	Inadequate chlorine in potable water *Legionella* water management program not comprehensive (i.e., testing for disinfectant and pH in potable water not required) Failure to recognize cases of Legionnaires' disease as being health care-associated Delayed reaction to contamination of potable water with *Legionella* because of 1) Unrecognized contamination (decreased sensitivity of samples because of small volume) 2) Reliance upon action threshold to prompt remediation (when health care–associated cases occurred below threshold) Failure of copper-silver ionization system to control *Legionella* colonization in hospital Extensive construction** at hospital Lack of start-up and shutdown procedure for decorative fountains Disinfectant not added to decorative fountain	✓	✓	✓	✓
Long-term care facility	Potable water	Temperatures in optimal range for *Legionella* growth† in hot potable water (because of anti-scalding regulations) Thermostatic mixing valves placed nearer to hot water heater than to faucet, creating long lengths of piping with temperatures in optimal range for *Legionella* growth† Inadequate disinfectant in potable water	✓			
Long-term care facility	Potable water	Inadequate disinfectant in potable water	✓			
Long-term care facility	Cooling tower	Inadequate disinfectant in cooling tower because of timed delivery that did not allow disinfectant to be delivered when cooling tower was not running			✓	

See table footnotes on page 583.

TABLE 2. (*Continued*) Deficiencies in water system maintenance contributing to growth and transmission of *Legionella* among outbreaks of Legionnaires' disease investigated by CDC — North America, 2000–2014 (n = 23)

Setting	Source	Deficiency	Category*			
			Process failure	Human error	Equipment failure	Unmanaged external change
Senior living facility	Potable water	Temperatures in optimal range for *Legionella* growth† in hot potable water because of reduction of hot water heater from original temperature set by the building's contractors Excessive sediment in potable water system because of new construction** Broken water main¶ during construction**		✓		✓
Senior living facility	Potable water	Temperatures in optimal range for *Legionella* growth† in hot potable water Inadequate disinfectant in potable water Failure to follow manufacturer's recommendations for periodic draining of hot water heaters to remove sediment Water temperature in hot water heater lower than indicated on thermostat Maintenance of water main¶ resulting in pressure disruptions and water outage	✓	✓	✓	✓
Community	Cooling tower	Tropical storm with heavy rain and flooding immediately before symptom onset of first case††				✓
Community	Decorative fountain	Inadequate maintenance of decorative fountain		✓		
Workplace	Cooling tower	Lack of start-up and shutdown procedures for cooling tower Lack of staff training on operation and maintenance of cooling tower Cooling tower dysfunction, prompting opening of windows Heavy rainfall, high humidity, and warm temperatures preceded onset of cases††	✓		✓	✓
Total			**15**	**12**	**8**	**8**

* Each reviewer independently assigned findings to one or more of four categories: 1) process failures, in which a process, such as a water management program, was missing or is inadequate; 2) human errors, in which a person did not perform as expected (e.g., not replacing hot tub filters according to manufacturer's recommendations); 3) equipment failures, in which a piece of equipment did not operate as expected (e.g., a malfunctioning disinfectant delivery system); and 4) unmanaged external changes, in which adjustments were not made to account for events outside a building water system (e.g., nearby construction leading to changes in potable water quality).

† Although recovery of *Legionella* from water with temperatures outside this range have occurred, the temperature range most favorable for growth of *Legionella* is 25°C–42°C (77°F–108°F). For health care facilities, ASHRAE Guideline 12–2000 recommends storing and distributing cold water at <20°C (68°F), whereas hot water should be stored at >60°C (140°F) and circulated with a minimum return temperature of 51°C (124°F). In other settings, hot water should be stored at ≥40°C (≥120°F).

§ Water stagnation encourages biofilm growth, reduces temperature, and reduces levels of disinfectant.

¶ Broken water mains lead to changes in water pressure which can dislodge biofilm (thereby freeing *Legionella* into water entering the building) and can introduce particulate matter into water entering the building (which can consume disinfectant).

** Vibrations and changes in water pressure experienced during construction can dislodge biofilm and free *Legionella* into the water entering the building.

†† Investigators suspect inadequate maintenance of cooling towers (with inadequate disinfectant) a heavy rain.

The findings in this report are subject to at least three limitations. First, the scope of legionellosis encompasses Legionnaires' disease and Pontiac fever. Because fatality is only associated with Legionnaires' disease, prevention messages are generally targeted toward preventing Legionnaires' disease and not Pontiac fever; therefore, the Pontiac fever cases in the five outbreaks reporting Pontiac fever (range = 1–101 cases) were excluded. Second, although understanding the clinical aspects of Legionnaires' disease is an essential step in addressing the increasing number of reported cases, these aspects have been reported elsewhere (*6*,*16*) and are not discussed here. Finally, this analysis might not capture all possible gaps in maintenance for several reasons. CDC typically completes investigation summaries within a few weeks of an investigation and investigators might not have had access to environmental information that might have become available later. In addition, CDC does not participate in all investigations of outbreaks of Legionnaires' disease; thus, these findings might not represent all root causes associated with outbreaks. Moreover, the outbreak-associated deficiencies described in this report might not represent root causes associated with sporadic Legionnaires' disease cases.

Missed prevention opportunities can lead to outbreaks of Legionnaires' disease. Making water management programs a routine part of building ownership and management will require education and reinforcement. Environmental and public health professionals can help by incorporating the ASHRAE standard into licensing and accreditation requirements, modifying building and public health codes to include

water management programs, and providing tools and information to help local building owners and managers implement water management programs. Future studies should evaluate the implementation and effectiveness of water management programs in buildings with large or complex water systems. Widespread use of such programs might reduce the growth and transmission of *Legionella*, which, in addition to early diagnosis with appropriate clinical testing, might reduce the number and size of Legionnaires' disease outbreaks and help reduce the occurrence of Legionnaires' disease in the United States.

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References

1. Adams D, Fullerton K, Jajosky R, et al. Summary of notifiable infectious diseases and conditions—United States, 2013. MMWR Morb Mortal Wkly Rep 2015;62:1–122. http://dx.doi.org/10.15585/mmwr.mm6253a1
2. CDC. Notice to readers: final 2014 reports of nationally notifiable infectious diseases. MMWR Morb Mortal Wkly Rep 2015;64:1019–33. http://dx.doi.org/10.15585/mmwr.mm6436a8
3. Dooling KL, Toews KA, Hicks LA, et al. Active bacterial core surveillance for legionellosis—United States, 2011–2013. MMWR Morb Mortal Wkly Rep 2015;64:1190–3. http://dx.doi.org/10.15585/mmwr.mm6442a2
4. Beer KD, Gargano JW, Roberts VA, et al. Surveillance for waterborne disease outbreaks associated with drinking water—United States, 2011–2012. MMWR Morb Mortal Wkly Rep 2015;64:842–8. http://dx.doi.org/10.15585/mmwr.mm6431a2
5. CDC. Waterborne disease and outbreak surveillance system. Atlanta, GA: US Department of Health and Human Services, CDC; 2016. http://www.cdc.gov/healthywater/surveillance/surveillance-reports.html
6. Hicks LA, Garrison LE, Nelson GE, et al. Legionellosis—United States, 2000–2009. MMWR Morb Mortal Wkly Rep 2011;60:1083–6.
7. Fields BS, Benson RF, Besser RE. *Legionella* and Legionnaires' disease: 25 years of investigation. Clin Microbiol Rev 2002;15:506–26. http://dx.doi.org/10.1128/CMR.15.3.506-526.2002
8. Correia AM, Ferreira JS, Borges V, et al. Probable person-to-person transmission of Legionnaires' disease. N Engl J Med 2016;374:497–8. http://dx.doi.org/10.1056/NEJMc1505356
9. Mercante JW, Winchell JM. Current and emerging *Legionella* diagnostics for laboratory and outbreak investigations. Clin Microbiol Rev 2015;28:95–133. http://dx.doi.org/10.1128/CMR.00029-14
10. ASHRAE. Legionellosis: risk management for building water systems. ANSI/ASHRAE Standard 188–2015. Atlanta, GA: ASHRAE; 2015. http://www.mesc.org/downloads/v/PCTI/ASHRAE%20188%20-%202015%20FINAL.pdf
11. Kozak NA, Benson RF, Brown E, et al. Distribution of lag-1 alleles and sequence-based types among *Legionella pneumophila* serogroup 1 clinical and environmental isolates in the United States. J Clin Microbiol 2009;47:2525–35. http://dx.doi.org/10.1128/JCM.02410-08
12. ASHRAE. Minimizing the risk of legionellosis associated with building water systems. ASHRAE guideline 12-2000. Atlanta, GA: ASHRAE; 2000. http://legionella.org/publications/non-visible/ashrae-guideline-12-2000/
13. Demirjian A, Lucas CE, Garrison LE, et al. The importance of clinical surveillance in detecting Legionnaires' disease outbreaks: a large outbreak in a hospital with a *Legionella* disinfection system—Pennsylvania, 2011–2012. Clin Infect Dis 2015;60:1596–602. http://dx.doi.org/10.1093/cid/civ153
14. Silk BJ, Moore MR, Bergtholdt M, et al. Eight years of Legionnaires' disease transmission in travellers to a condominium complex in Las Vegas, Nevada. Epidemiol Infect 2012;140:1993–2002. http://dx.doi.org/10.1017/S0950268811002779
15. CDC. Cruise-ship—associated Legionnaires disease, November 2003–May 2004. MMWR Morb Mortal Wkly Rep 2005;54:1153–5.
16. Phin N, Parry-Ford F, Harrison T, et al. Epidemiology and clinical management of Legionnaires' disease. Lancet Infect Dis 2014;14:1011–21. http://dx.doi.org/10.1016/S1473-3099(14)70713-3

Notes from the Field

Intoxication and Deaths Associated with Ingestion of a Racing Fuel and Carbonated Soft Drink Mixture — Tennessee, January 2016

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In January 2016, the Tennessee Poison Center and Tennessee Department of Health learned of the deaths of two adolescents, and the nonfatal intoxication of two other adolescents, after ingestion of a mixture of racing fuel (approximately 100% methanol) and a carbonated soft drink. The Tennessee Department of Health reviewed medical records and police reports to learn more about the racing fuel source, assess ongoing risk, and guide prevention efforts. These are the first reported deaths in the United States associated with ingestion of this racing fuel mixture.

Police investigators reported that one of the decedents obtained approximately one half gallon (1.9 L) of an unknown brand of racing fuel from a family friend's residence. Unknown quantities of racing fuel and the carbonated soft drink were subsequently mixed in a 2L bottle, and consumed at a party, presumably as a substitute for ethyl alcohol. The two surviving adolescents reported drinking approximately 2 ounces (59 mL) of the mixture. The amount consumed by the two decedents is unknown, although an empty 2L bottle was recovered at the scene. According to police reports, no other adolescents interviewed reported ingesting the mixture.

The first decedent, a male aged 16 years, was found dead at home approximately 11 hours after ingesting the mixture. The second decedent, also a male aged 16 years, was observed having seizure-like activity at home approximately 12 hours after ingestion and was transported to a local emergency department. Initial laboratory tests were notable for severe metabolic acidosis and a blood methanol level of 175 mg/dL (the presence of any methanol is abnormal). He was treated with aggressive measures, including fomepizole, a competitive inhibitor of alcohol dehydrogenase, and hemodialysis; however, he died 5 days after ingestion. The two surviving adolescents were evaluated in emergency departments 20–23 hours after ingestion, reported to have normal laboratory evaluations, and released.

The life-threatening component of the consumed mixture, racing fuel, is approximately 100% methanol. Methanol is an organic solvent commonly found in laboratory, industrial, automotive, and residential products (*1*). Methanol is metabolized to formaldehyde and then to formic acid, which accumulates in the optic nerve and optic disc and is highly cytotoxic (*2*). As little as 15 ml (0.5 ounce or 1 tablespoon) of methanol can be fatal (*1*).

The initial signs and symptoms of methanol intoxication are similar to those of ethanol intoxication. After a latent period of 6–36 hours, depending upon the amount ingested, patients develop drowsiness and gastrointestinal symptoms (nausea, vomiting, and abdominal pain), reflecting the metabolism of methanol, via formaldehyde, to formic acid. Concomitant consumption of ethanol can prolong the latent period (*2*). Later, more serious symptoms, including visual disturbances, abnormal respiration, altered mental status, seizures (related to metabolic derangement or brain injury), cerebral edema, and death, can occur (*2–4*). However, the absence of severe signs or symptoms after ingestion should not deter medical evaluation (*1*); early medical assessment and rapid treatment can increase chances for survival (*2,5*).

The surviving adolescents had not heard of or consumed this racing fuel and carbonated soft drink mixture before; however, they reported that one of the decedents learned of the mixture on a trip to Kansas approximately 1 month earlier. State and national poison control and public health officials who were questioned were unaware of this practice. However, outbreaks of methanol poisoning caused by novice or illicit production of spirits have been previously documented in the United States and around the world, sometimes causing hundreds of deaths per outbreak (*6–8*). These dangerous beverages are produced as a cheap substitute for ethyl alcohol, often in areas where alcohol is banned or expensive. Methanol is a known byproduct of fermentation and is found at safe levels in most alcoholic beverages; however, if the distillation process is performed incorrectly, as can occur in home-brewed or illicit beverages, methanol levels can be dangerously elevated (*8*).

The American Association of Poison Control Centers' Toxic Exposure Surveillance System includes 7,183 reports of methanol exposure for the period 2011–2014; among these exposures, 660 (9.2%) were intentional. Among all 7,183 persons exposed, 477 (6.6%) patients who survived had symptoms of moderate or major toxicity,* and 33 (0.5%) died. However,

* From definitions used by the Toxic Exposure Surveillance System. Moderate toxicity: The patient exhibits some symptoms as a result of the exposure, but they are minimally bothersome. The symptoms usually resolve rapidly and often involve skin or mucous membrane manifestations. The patient returns to a preexposure state of well-being and has no residual disability or disfigurement (examples include mild gastrointestinal symptoms, drowsiness, and sinus tachycardia without hypotension). Major toxicity: The patient exhibits symptoms as a result of the exposure which are life-threatening or result in significant residual disability or disfigurement (examples include patients who require intubation and mechanical ventilation or have cardiovascular instability).

a more accurate estimate of the methanol case-fatality rate considers the proportion of deaths among all persons who had moderate or major toxicity (33 of 510 [6.5%]), because the persons in these groups were most likely to be at risk for death. With the exception of three patients (aged 13–19 years), all methanol exposure deaths occurred among persons aged ≥20 years (*9*).

Parents, community educators and leaders, and the medical and public health communities are important in the monitoring of similar practices among adolescents, and in consistently reinforcing the message that methanol is a highly toxic substance that can cause serious illness and death. The Tennessee Department of Health has developed educational materials for use by community educators statewide, including a one-page brief fact sheet and didactic presentation. These educational materials include background information on the mixture of racing fuel and the carbonated soft drink, symptoms of methanol ingestion, recommendations to seek medical care as soon as possible, and 24/7 contact information for the Tennessee Poison Center and Tennessee Department of Health. Collaborative prevention efforts among the Tennessee Poison Center, the Tennessee Department of Health, and local communities are ongoing.

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References

1. Kruse JA. Methanol and ethylene glycol intoxication. Crit Care Clin 2012;28:661–711. http://dx.doi.org/10.1016/j.ccc.2012.07.002
2. Barceloux DG, Bond GR, Krenzelok EP, Cooper H, Vale JA; American Academy of Clinical Toxicology Ad Hoc Committee on the Treatment Guidelines for Methanol Poisoning. American Academy of Clinical Toxicology practice guidelines on the treatment of methanol poisoning. J Toxicol Clin Toxicol 2002;40:415–46. http://dx.doi.org/10.1081/CLT-120006745
3. Fontenot AP, Pelak VS. Development of neurologic symptoms in a 26-year-old woman following recovery from methanol intoxication. Chest 2002;122:1436–9. http://dx.doi.org/10.1378/chest.122.4.1436
4. Lu JJ, Kalimullah EA, Bryant SM. Unilateral blindness following acute methanol poisoning. J Med Toxicol 2010;6:459–60. http://dx.doi.org/10.1007/s13181-010-0024-7
5. Hovda KE, Hunderi OH, Tafjord AB, Dunlop O, Rudberg N, Jacobsen D. Methanol outbreak in Norway 2002–2004: epidemiology, clinical features and prognostic signs. J Intern Med 2005;258:181–90. http://dx.doi.org/10.1111/j.1365-2796.2005.01521.x
6. Bennett IL Jr, Cary FH, Mitchell GL Jr, Cooper MN. Acute methyl alcohol poisoning: a review based on experiences in an outbreak of 323 cases. Medicine (Baltimore) 1953;32:431–63. http://dx.doi.org/10.1097/00005792-195312000-00002
7. Swartz RD, Millman RP, Billi JE, et al. Epidemic methanol poisoning: clinical and biochemical analysis of a recent episode. Medicine (Baltimore) 1981;60:373–82. http://dx.doi.org/10.1097/00005792-198109000-00005
8. World Health Organization. International Programme on Chemical Safety. Environmental health criteria no. 196: methanol. Geneva, Switzerland: World Health Organization; 1997.
9. American Association of Poison Control Centers. National Poison Data System: annual reports, 2011–2014. Alexandria, VA: American Association of Poison Control Centers. http://www.aapcc.org/annual-reports/

Erratum

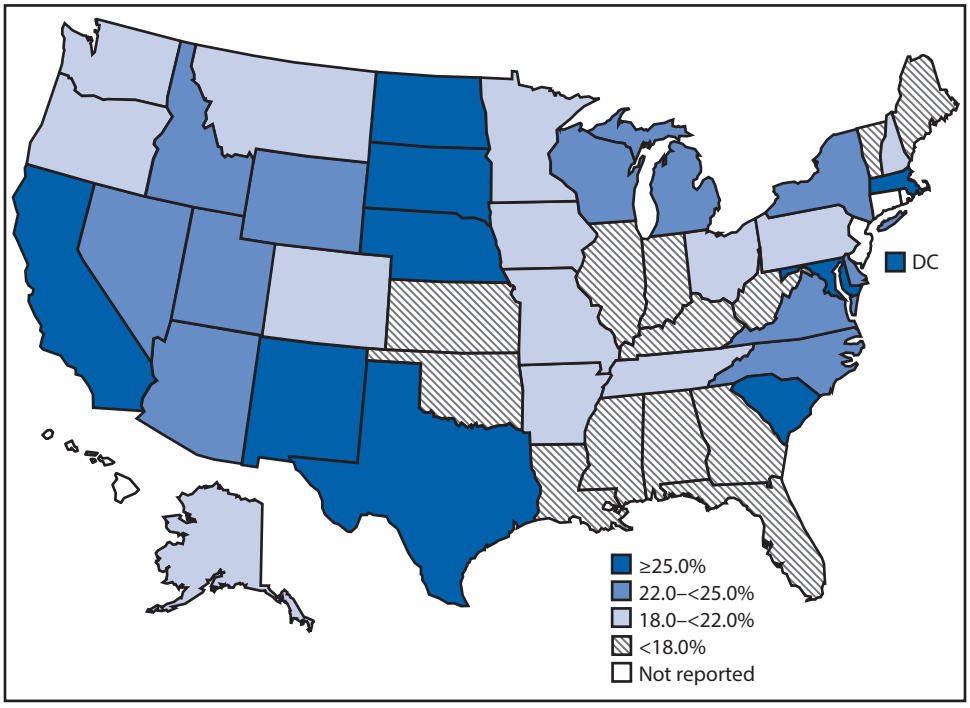
Vol. 65, No. 20

In the *MMWR* report, "Possible Zika Virus Infection Among Pregnant Women — United States and Territories, May 2016," the following persons should be included in the Zika and Pregnancy Working Group: "**Nina Ahmad, New York State Department of Health; Jennifer White, New York State Department of Health**."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Smoking Cessation* During Pregnancy — 46 States and the District of Columbia, 2014



* Women who ceased smoking during pregnancy are defined as those who reported cigarette smoking in either the first or second trimester and did not report smoking in the third trimester.

In 2014, 20.6% of pregnant women who smoked cigarettes during the first or second trimester, in a reporting area of 46 states and the District of Columbia, stopped smoking during pregnancy. Women in three states, South Dakota (31.3%), California (31.2%) and New Mexico (30.2%), as well as the District of Columbia (41.5%), reported the highest cessation rates during pregnancy. Kentucky (11.4%) and Maine (11.6%) reported the lowest cessation rates; cessation rates were generally lower for states in the Southeast. The reporting area included 3,819,113 births and represented 95% of all U.S. births in 2014.

Source: Curtin SC, Mathews TJ. Smoking prevalence and cessation before and during pregnancy: data from the birth certificate, 2014. Natl Vital Stat Rep 2016;65(1). http://www.cdc.gov/nchs/data/nvsr/nvsr65/nvsr65_01.pdf.

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