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Tobacco Use Among Middle and High School Students — United States, 2011–2015

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Tobacco use is the leading cause of preventable disease and death in the United States; if current smoking rates continue, 5.6 million Americans aged <18 years who are alive today are projected to die prematurely from smoking-related disease (*1*). Tobacco use and addiction mostly begin during youth and young adulthood (*1*,*2*). CDC and the Food and Drug Administration (FDA) analyzed data from the 2011–2015 National Youth Tobacco Surveys (NYTS) to determine the prevalence and trends of current (past 30-day) use of seven tobacco product types (cigarettes, cigars, smokeless tobacco, electronic cigarettes [e-cigarettes], hookahs [water pipes used to smoke tobacco], pipe tobacco, and bidis [small imported cigarettes wrapped in a tendu leaf]) among U.S. middle (grades 6–8) and high (grades 9–12) school students. In 2015, e-cigarettes were the most commonly used tobacco product among middle (5.3%) and high (16.0%) school students. During 2011–2015, significant increases in current use of e-cigarettes and hookahs occurred among middle and high school students, whereas current use of conventional tobacco products, such as cigarettes and cigars decreased, resulting in no change in overall tobacco product use. During 2014–2015, current use of e-cigarettes increased among middle school students, whereas current use of hookahs decreased among high school students; in contrast, no change was observed in use of hookahs among middle school students, use of e-cigarettes among high school students, or use of cigarettes, cigars, smokeless tobacco, pipe tobacco, or bidis among middle and high school students. In 2015, an estimated 4.7 million middle and high school students were current tobacco product users, and, therefore, continue to be exposed to harmful tobacco product constituents, including nicotine. Nicotine exposure during adolescence, a critical period for brain development, can cause addiction, might harm brain development, and could lead to sustained tobacco product use among youths (*1*,*3*). Comprehensive and sustained strategies are warranted to prevent and reduce the use of all tobacco products among U.S. youths.

The NYTS is a cross-sectional, school-based, self-administered, pencil-and-paper questionnaire administered to U.S. middle school and high school students. Information is collected on tobacco control outcome indicators to monitor the impact of comprehensive tobacco control policies and strategies (*4*) and to inform the FDA's regulatory actions (*5*). A three-stage cluster sampling

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procedure was used to generate a nationally representative sample of U.S. students attending public and private schools in grades 6–12. This report uses data from 5 years of NYTS (2011–2015). Sample sizes and overall response rates for 2011, 2012, 2013, 2014, and 2015 were 18,866 (72.7%), 24,658 (73.6%), 18,406 (67.8%), 22,007 (73.3%), and 17,711 (63.4%), respectively.

Participants were asked about current (past 30-day) use of cigarettes, cigars, smokeless tobacco,* e-cigarettes,† hookahs,§ pipe tobacco,¶ and bidis. Current use for each product was defined as use on ≥1 day during the past 30 days. Current tobacco use was categorized as "any tobacco product use," defined as use of one or more tobacco products in the past 30 days; and "≥2 tobacco product use," defined as use of two or more tobacco products in the past 30 days.** Kreteks (sometimes referred to as clove cigarettes) are no longer legally sold in the United States, and were excluded from the definition of current any tobacco product use, consistent with other recent reports.†† Data were weighted to account for the complex survey design and adjusted for nonresponse; national prevalence estimates with 95% confidence intervals and population estimates rounded down to the nearest 10,000 were computed. Estimates for current use in 2015 are presented for any tobacco product use, use of ≥2 tobacco products, and use of each tobacco product, by selected

* The definition of smokeless tobacco in this report includes chewing tobacco/snuff/dip, snus, and dissolvable tobacco because of limited sample sizes. The definition of smokeless tobacco in previously published NYTS reports included only chewing tobacco/snuff/dip, whereas snus and dissolvable tobacco were reported as separate products.

† In 2015, current use of e-cigarettes was assessed by the question "During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes." E-cigarette questions were preceded by an introductory paragraph: "The next twelve questions are about electronic cigarettes or e-cigarettes. E-cigarettes are electronic devices that usually contain a nicotine-based liquid that is vaporized and inhaled. You may also know them as vape-pens, hookah-pens, electronic hookahs (e-hookahs), electronic cigars (e-cigars), electronic pipes (e-pipes), or e-vaporizers. Some look like cigarettes and others look like pens or small pipes. These are battery-powered devices that produce vapor instead of smoke. Some brands examples are NJOY, Blu, VUSE, MarkTen, Finiti, Starbuzz, and Fantasia." In 2014, current use of e-cigarettes was assessed by the question "During the past 30 days, on how many days did you use e-cigarettes such as Blu, 21st Century Smoke, or NJOY?"; and in 2011 to 2013, e-cigarette use was assessed by the question "In the past 30 days, which of the following products have you used on at least one day?," and the response option for e-cigarettes was "Electronic cigarettes or e-cigarettes such as Ruyan or NJOY."

§ In 2015, current use of hookahs was assessed by the question "In the past 30 days, which of the following products have you used on at least one day?" and was the fourth response option available to be selected; in 2014, hookah use was the first response option; whereas from 2011 to 2013, hookah was the fourth or fifth response option.

¶ In 2014 and 2015, current use of tobacco pipes was assessed by the question "In the past 30 days, which of the following products have you used on at least one day?" and the response option for pipe tobacco was "Pipe filled with tobacco (not waterpipe)." From 2011 to 2013, tobacco pipe use was assessed by the question "During the past 30 days, on how many days did you smoke tobacco in a pipe?"

** The definition of ≥2 tobacco product use includes the updated definition of smokeless tobacco, thereby analyzing chewing tobacco/snuff/dip, snus, and dissolvable tobacco as a single tobacco product type compared with previously published NYTS reports, which analyzed chewing tobacco/snuff/dip, snus, and dissolvable tobacco as separate products.

†† Kreteks are no longer legally sold in the United States; therefore, data on these products were not collected in the 2014 and 2015 cycles of NYTS. Also, kreteks were not included in the definition of "any tobacco product use" in years when data were collected to assess trends across the study period (2011, 2012, and 2013).

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demographics for each school level (high and middle). Results were assessed for the presence of linear and quadratic trends to determine the overall trend present, adjusting for race/ethnicity, sex, and grade; p-value <0.05 was used to determine statistical significance.[§§] T-tests were performed to examine differences between estimates from 2014 and 2015; p-values <0.05 were considered statistically significant.

In 2015, 25.3% of high school students reported current use of any tobacco product, including 13.0% who reported current use of ≥2 tobacco products. Among all high school students, e-cigarettes (16.0%) were the most commonly used tobacco product, followed by cigarettes (9.3%), cigars (8.6%), hookahs (7.2%), smokeless tobacco (6.0%), pipe tobacco (1.0%), and bidis (0.6%) (Table). Males reported higher use of any tobacco, ≥2 tobacco products, e-cigarettes, cigarettes, cigars, smokeless tobacco, and bidis than did females. Among non-Hispanic white and Hispanic high school students, e-cigarettes were the most commonly used tobacco product, whereas among non-Hispanic black high school students, cigars were most commonly used. Cigarette use was higher among non-Hispanic whites than among non-Hispanic blacks; and smokeless tobacco use was higher among non-Hispanic whites than other races.

Among middle school students, current use of any tobacco product and ≥2 tobacco products was 7.4% and 3.3%, respectively (Table). E-cigarettes (5.3%) were the most commonly used tobacco product by middle school students, followed by cigarettes (2.3%), hookahs (2.0%), smokeless tobacco (1.8%), cigars (1.6%), pipe tobacco (0.4%), and bidis (0.2%). As was the case among high school students, male middle school students reported higher use of any tobacco product than did females. Hispanic middle school students reported higher use of any tobacco product, use of ≥2 tobacco products, and use of e-cigarettes compared with that of other races/ethnicities.

During 2014–2015, current use of hookahs declined among high school students. Use of all other tobacco products, including e-cigarettes, cigarettes, cigars, and smokeless tobacco remained unchanged during this time period among high school students. Among middle school students, e-cigarette use increased from 3.9% in 2014 to 5.3% in 2015. Use of other tobacco products, including cigarettes, cigars, hookahs, and smokeless tobacco remained unchanged.

During 2011–2015, among all high school students, significant nonlinear increases were observed for current use of e-cigarettes (1.5% to 16.0%) and hookahs (4.1% to 7.2%) (Figure 1). Significant linear decreases were observed for current use of cigarettes (15.8% to 9.3%) and smokeless tobacco (7.9% to 6.0%), and significant nonlinear decreases were observed for current use of cigars (11.6% to 8.6%), pipe tobacco (4.0% to 1.0%), and bidis (2.0% to 0.6%). Current use of any tobacco product (24.2% to 25.3%) did not change significantly during 2011–2015. Among middle school students, significant linear increases were observed for current use of e-cigarettes (0.6% to 5.3%) and hookahs (1.0% to 2.0%) (Figure 2). Significant linear decreases were observed for current use of cigarettes (4.3% to 2.3%), cigars (3.5% to 1.6%), and smokeless tobacco (2.7% to 1.8%), and significant nonlinear decreases were observed for current use of pipe tobacco (2.2% to 0.4%) and bidis (1.7% to 0.2%). There was also a significant nonlinear change in the percentage of middle school students reporting current use of ≥2 tobacco products.

In 2015, an estimated 4.7 million middle and high school students were current users of any tobacco product, over 2.3 million of whom were current users of ≥2 tobacco products. Among middle and high school current tobacco users,

Summary

What is already known about this topic?

Tobacco use and addiction mostly begin during youth and young adulthood. Nicotine exposure during adolescence can cause addiction, might harm brain development, and could lead to sustained tobacco product use among youths.

What is added by this report?

In 2015, one in four high school students and one in 13 middle school students reported current use of any tobacco product (≥1 day in the past 30 days). An estimated 4.7 million high school and middle school students reported current use of any tobacco product. During 2011–2015, substantial increases were observed in e-cigarette and hookah use among high school and middle school students, whereas significant decreases were observed in the use of cigarettes, cigars, smokeless tobacco, pipe tobacco, and bidis, resulting in no decline in tobacco use overall. During 2015, electronic cigarettes (e-cigarettes) were the most commonly used tobacco product among middle (5.3%) and high (16.0%) school students.

What are the implications for public health practice?

Use of emerging tobacco products, including e-cigarettes, is on the rise among middle and high school students; therefore, it is critical that comprehensive tobacco control and prevention strategies for youths address all tobacco products and not just cigarettes.

[§§] A test for linear trend is significant if an overall statistically significant decrease or increase occurs during the study period. Data were also assessed for the presence of quadratic trends; a significant quadratic trend indicates that the rate of change accelerated or decelerated across the study period. Trends were only assessed when statistically stable data were available for all 5 years. A significant positive linear trend and nonsignificant quadratic trend signifies the presence of a linear increase; a significant negative linear trend and nonsignificant quadratic trends signifies the presence of a linear decrease; a significant positive linear trend and significant positive or negative quadratic trend signifies the presence of a nonlinear increase; a significant negative linear trend and significant positive or negative quadratic trend signifies the presence of a nonlinear decrease; a nonsignificant linear trend and significant positive or negative quadratic trend signifies the presence of a nonlinear change.

TABLE. Estimated percentage of tobacco use in the past 30 days, by product,* school level, sex, and race/ethnicity — National Youth Tobacco Survey, United States, 2015

	Sex		Race/Ethnicity				Total	
Tobacco product	Female % (95% CI)	Male % (95% CI)	Non-Hispanic white % (95% CI)	Non-Hispanic black % (95% CI)	Hispanic % (95% CI)	Non-Hispanic other race % (95% CI)	% (95% CI)	Estimated number of users†
High school students								
Electronic cigarettes	12.8 (11.0–15.0)	19.0 (16.5–21.7)	17.2 (14.7–19.9)	8.9 (7.4–10.8)	16.4 (14.1–19.0)	18.9 (10.3–32.2)	**16.0 (14.1–18.0)**	**2,390,000**
Cigarettes	7.7 (6.3–9.3)	10.7 (8.9–12.9)	10.2 (8.4–12.3)	5.7 (3.2–10.0)	9.0 (7.0–11.7)	7.5 (5.0–10.9)	**9.3 (7.8–10.9)**	**1,370,000**
Cigars	5.6 (4.7–6.8)	11.5 (10.1–13.1)	8.4 (7.2–9.9)	12.8 (9.5–17.0)	7.3 (5.8–9.1)	5.9 (3.8–9.1)	**8.6 (7.6–9.8)**	**1,270,000**
Hookah	6.9 (5.6–8.4)	7.4 (6.5–8.5)	6.9 (5.6–8.4)	6.4 (4.8–8.5)	8.7 (7.5–10.1)	6.4 (4.6–8.9)	**7.2 (6.3–8.2)**	**1,040,000**
Smokeless tobacco	1.8 (1.2–2.7)	10.0 (8.0–12.5)	7.8 (5.9–10.2)	1.9 (1.1–3.4)	4.8 (3.8–6.1)	2.7 (1.6–4.6)	**6.0 (4.7–7.6)**	**900,000**
Pipe tobacco	0.7 (0.4–1.2)	1.4 (0.9–2.0)	1.0 (0.7–1.6)	—§	1.5 (1.1–2.2)	—	**1.0 (0.8–1.4)**	**150,000**
Bidis	0.4 (0.2–0.6)	0.9 (0.6–1.4)	0.5 (0.3–0.9)	—	—	—	**0.6 (0.4–0.9)**	**90,000**
Any tobacco product use¶	20.3 (18.0–22.9)	30.0 (27.4–32.8)	26.2 (23.2–29.4)	21.9 (18.7–25.5)	25.4 (22.6–28.3)	25.3 (16.9–36.1)	**25.3 (23.1–27.6)**	**3,820,000**
≥2 tobacco product use**	9.6 (8.0–11.6)	16.2 (14.5–18.0)	14.2 (12.0–16.7)	9.5 (6.8–13.0)	13.0 (11.1–15.3)	9.4 (6.8–12.8)	**13.0 (11.5–14.7)**	**1,960,000**
Middle school students								
Electronic cigarettes	4.8 (4.0–5.6)	5.9 (4.7–7.2)	4.4 (3.6–5.5)	4.1 (3.1–5.3)	8.3 (6.8–10.0)	4.6 (2.7–7.7)	**5.3 (4.6–6.2)**	**620,000**
Cigarettes	2.2 (1.6–3.1)	2.3 (1.7–3.1)	2.1 (1.4–3.3)	1.0 (0.6–1.6)	2.8 (2.0–4.0)	2.7 (1.5–4.8)	**2.3 (1.7–3.0)**	**260,000**
Cigars	1.4 (1.0–2.0)	1.8 (1.3–2.5)	1.2 (0.7–1.9)	2.0 (1.4–2.8)	2.2 (1.5–3.1)	—	**1.6 (1.2–2.1)**	**180,000**
Hookah	2.0 (1.4–2.9)	1.9 (1.4–2.6)	1.6 (1.0–2.5)	—	3.2 (2.3–4.4)	—	**2.0 (1.5–2.6)**	**220,000**
Smokeless tobacco	1.1 (0.8–1.7)	—	—	—	2.7 (1.8–4.0)	—	**1.8 (1.1–2.8)**	**210,000**
Pipe tobacco	—	—	—	—	—	—	**0.4 (0.3–0.6)**	**40,000**
Bidis	—	—	—	—	—	—	**0.2 (0.1–0.4)**	**20,000**
Any tobacco product use	6.4 (5.4–7.6)	8.3 (6.7–10.3)	6.3 (4.8–8.2)	6.6 (5.3–8.1)	10.6 (9.0–12.4)	5.6 (3.7–8.5)	**7.4 (6.3–8.7)**	**880,000**
≥2 tobacco product use	3.1 (2.4–3.9)	3.5 (2.7–4.5)	2.6 (1.8–3.7)	2.2 (1.5–3.1)	5.4 (4.3–6.6)	—	**3.3 (2.6–4.0)**	**390,000**

Abbreviation: CI = confidence interval.

* Past 30-day use of cigarettes was determined by asking, "During the past 30 days, on how many days did you smoke cigarettes?"; Past 30-day use of cigars was determined by asking, "During the past 30 days, on how many days did you smoke cigars, cigarillos, or little cigars?"; Smokeless tobacco was defined as use of chewing tobacco/snuff/dip, snus, and/or dissolvable tobacco. Past 30-day use of smokeless tobacco was determined by asking the following question for use of chewing tobacco/snuff/dip: "During the past 30 days, on how many days did you use chewing tobacco, snuff, or dip?," and the following question for use of snus and dissolvable tobacco: "In the past 30 days, which of the following products have you used on at least one day?," and combining responses together to derive use. Past 30-day use of electronic cigarettes was determined by asking, "During the past 30 days, on how many days did use electronic cigarettes or e–cigarettes?"; past 30-day use of hookahs, pipe tobacco (not hookah), and bidis, were determined by asking, "In the past 30 days, which of the following products have you used on at least one day?"

† Estimated total number of users is rounded down to the nearest 10,000.

§ Data are statistically unreliable because sample size <50 or relative standard error >0.3.

¶ Any tobacco product use is past 30-day use of cigarettes, cigars, smokeless tobacco, electronic cigarettes, hookahs, pipe tobacco, and/or bidis on ≥1 day in the past 30 days.

** ≥2 tobacco product use is past 30-day use of two or more of cigarettes, cigars, smokeless tobacco, electronic cigarettes, hookahs, pipe tobacco, and/or bidis on ≥1 day in the past 30 days.

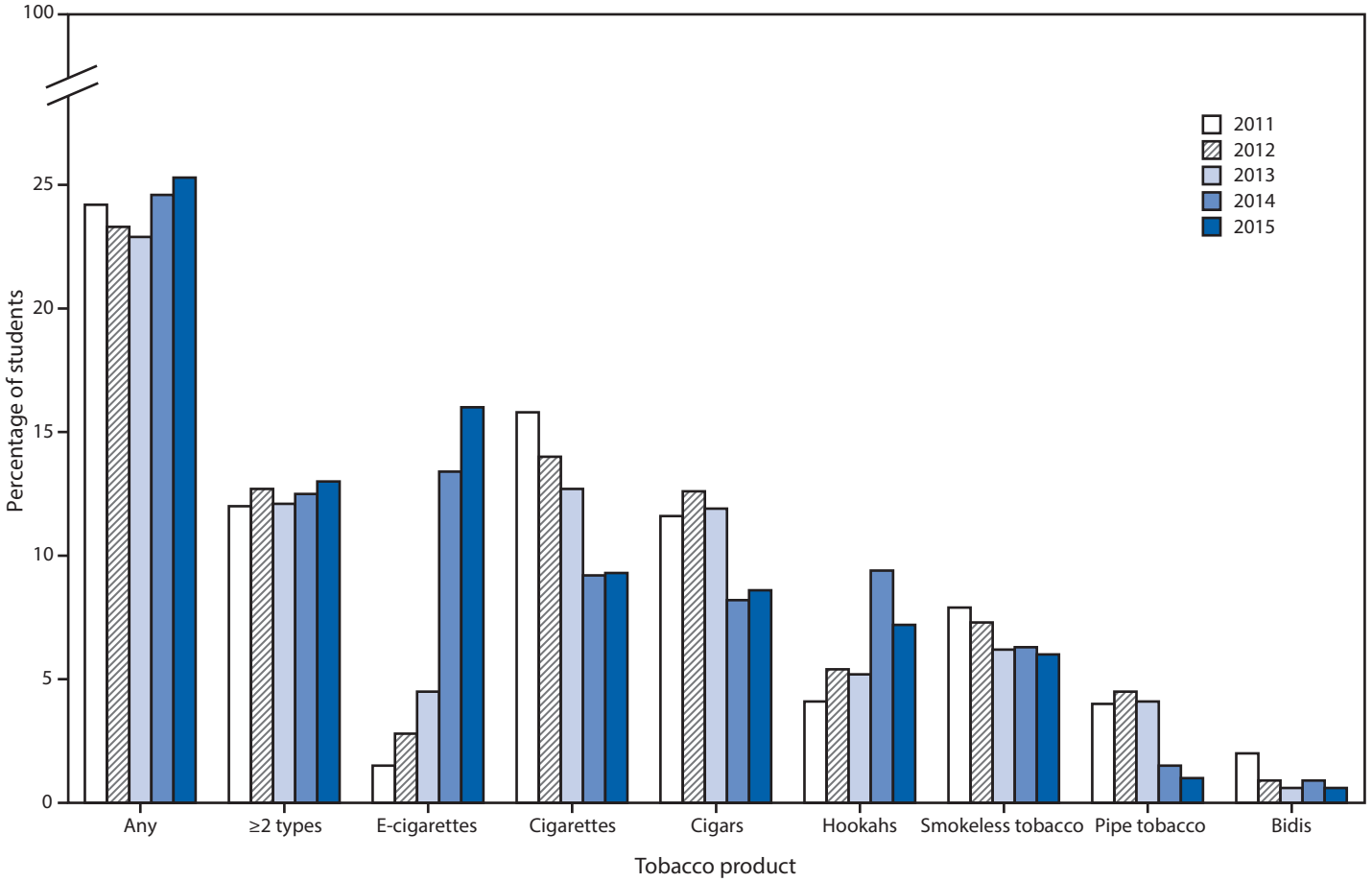
3.0 million used e-cigarettes, 1.6 million used cigarettes, 1.4 million used cigars, 1.2 million used hookahs, and 1.1 million used smokeless tobacco.

Discussion

During 2011–2015, there was no change in current use of any tobacco product among middle and high school students, and in 2015, an estimated 4.7 million U.S. middle and high school students currently used any tobacco product. As in 2014, e-cigarettes were the most used tobacco product among U.S. middle and high school students in 2015. During 2011–2015, substantial increases in current e-cigarette use among middle and high school students were reported, resulting in an estimated total of 3.0 million middle school and high school e-cigarette users in 2015. Although the use of cigarettes and cigars declined during 2011–2015, there was no change in use of these products during 2014–2015, making cigarettes (1.6 million) and cigars (1.4 million) the second and third most commonly used tobacco products among youths in 2015.

Tobacco prevention and control strategies, including increasing tobacco product prices, adopting comprehensive smoke-free laws, and implementation of national public education media campaigns, likely have contributed to the reduction in use of certain tobacco products, including cigarettes, among youths in recent years (*2*). However, the lack of decline in use of cigarettes and cigars from 2014 to 2015 is concerning, as approximately 80% of adult smokers first try smoking by age 18 years (*2*). Furthermore, because of increases in the use of

FIGURE 1. Estimated percentage of high school students who currently use any tobacco products,* ≥2 tobacco products,† and select tobacco products§ — National Youth Tobacco Survey 2011–2015



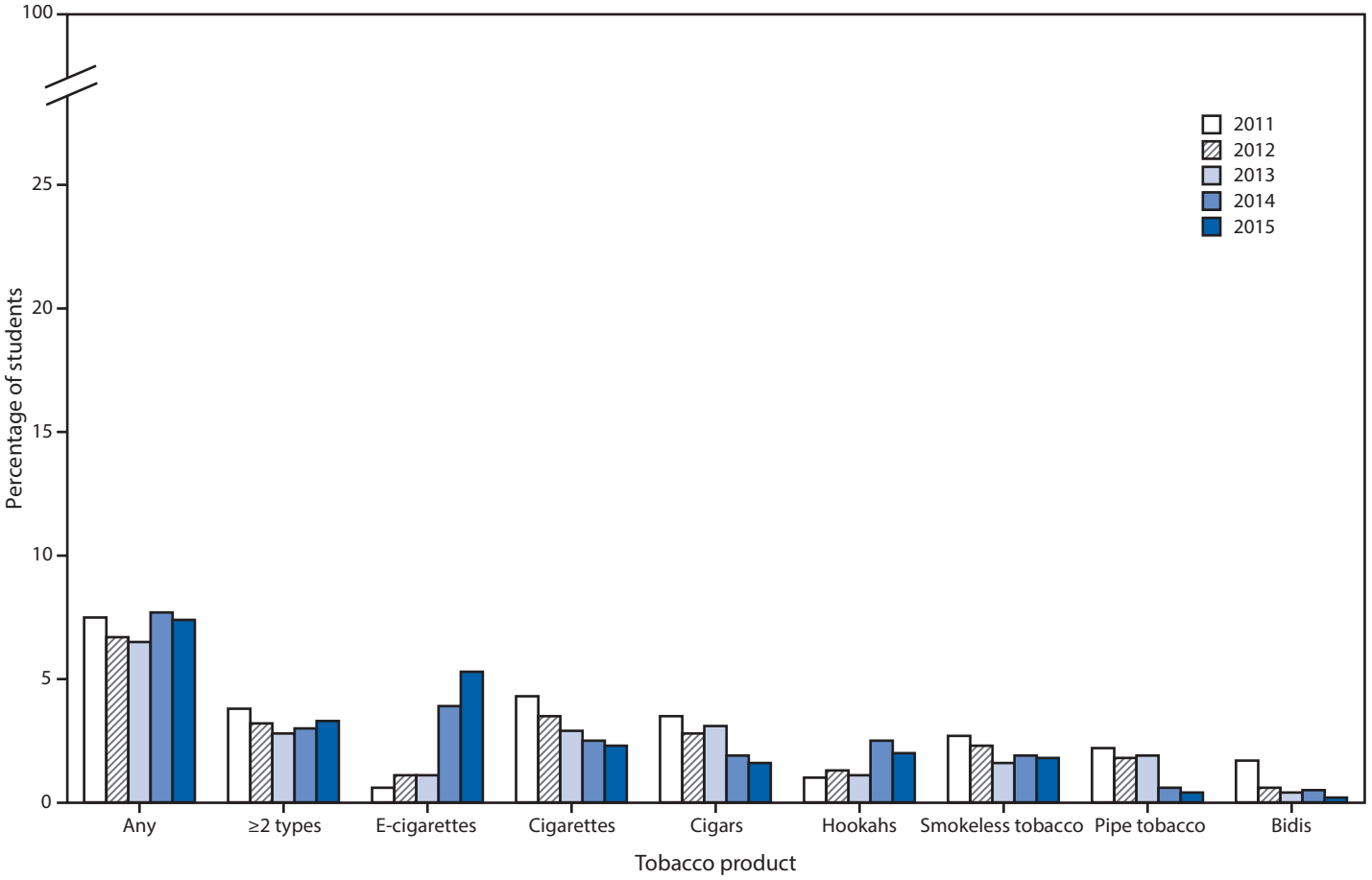
* Any tobacco product use is defined as past 30-day use of cigarettes, cigars, smokeless tobacco, e-cigarettes, hookahs, pipe tobacco , and/or bidis.
† ≥2 tobacco product use is defined as past 30-day use of two or more of the following product types: cigarettes, cigars, smokeless tobacco, e-cigarettes, hookahs, pipe tobacco, and/or bidis.
§ E-cigarettes and hookahs demonstrated a nonlinear increase ($p<0.05$). Cigarettes and smokeless tobacco demonstrated a linear decrease ($p<0.05$). Cigars, pipe tobacco, and bidis demonstrated a nonlinear decrease ($p<0.05$).

emerging tobacco products, including e-cigarettes, no decline occurred in tobacco use overall during 2011–2015.

The findings in this report are subject to at least four limitations. First, NYTS only recruited middle and high school students from public and private schools in the United States; therefore, the findings might not be generalizable to youths who are being home-schooled, have dropped out of school, or are in detention centers. Second, data were self-reported; thus, the findings are subject to recall and response bias. Third, current tobacco use was estimated among students reporting their use status for at least one of the seven tobacco products included in the survey, whereas students with missing responses were considered nonusers of that product, which would result in conservative estimates. Finally, changes in the wording and placement of survey questions about the use of certain products (e.g., e-cigarettes, hookahs, and pipe tobacco) within the 2011–2015 period might have had an impact on reported use of these products; however, this possibility is difficult to assess because usage patterns were changing during this time period. Despite these limitations, overall trends are generally similar to other nationally representative surveys of tobacco use among youths (*6*,*7*).

Sustained efforts to implement proven tobacco control policies and strategies are necessary to prevent youth use of all tobacco products. In April 2014, FDA issued a proposed rule, which when finalized, would give FDA jurisdiction over products made or derived from tobacco, including e-cigarettes, some or all cigars, pipe tobacco, and hookah tobacco (*8*). Regulation of the manufacturing, distribution, and marketing of tobacco products by FDA, coupled with full implementation of comprehensive tobacco control and prevention strategies at CDC-recommended funding levels (*9*) could reduce youth tobacco

FIGURE 2. Estimated percentage of middle school students who currently use any tobacco products,* ≥2 tobacco products,†,§ and select tobacco products¶ in the past 30 days — National Youth Tobacco Survey, 2011–2015



* Any tobacco product use is defined as past 30-day use of cigarettes, cigars, smokeless tobacco, e-cigarettes, hookahs, pipe tobacco, and/or bidis.
† ≥2 tobacco product use is defined as past 30-day use of two or more of the following product types: cigarettes, cigars, smokeless tobacco, e-cigarettes, hookahs, pipe tobacco, and/or bidis.
§ ≥2 tobacco product use demonstrated a nonlinear change ($p<0.05$).
¶ E-cigarettes and hookahs demonstrated a linear increase ($p<0.05$). Cigarettes, cigars, and smokeless tobacco demonstrated a linear decrease ($p<0.05$). Pipe tobacco and bidis demonstrated a nonlinear decrease ($p<0.05$).

initiation and use (*1*,*2*,*9*). Given that the use of e-cigarettes is on the rise among middle and high school students and nicotine exposure from any source is dangerous for youths (*2*), it is critical that comprehensive tobacco control and prevention strategies for youths address all tobacco products and not just cigarettes. In addition, rapid changes in use of conventional and emerging tobacco products among youths, and varying prevalence of certain tobacco products by population groups underscore the importance of enhanced surveillance of all forms of tobacco product use among U.S. youths.

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Infection with Pathogens Transmitted Commonly Through Food and the Effect of Increasing Use of Culture-Independent Diagnostic Tests on Surveillance — Foodborne Diseases Active Surveillance Network, 10 U.S. Sites, 2012–2015

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To evaluate progress toward prevention of enteric and foodborne illnesses in the United States, the Foodborne Diseases Active Surveillance Network (FoodNet) monitors the incidence of laboratory-confirmed infections caused by nine pathogens transmitted commonly through food in 10 U.S. sites.* This report summarizes preliminary 2015 data and describes trends since 2012. In 2015, FoodNet reported 20,107 confirmed cases (defined as culture-confirmed bacterial infections and laboratory-confirmed parasitic infections), 4,531 hospitalizations, and 77 deaths. FoodNet also received reports of 3,112 positive culture-independent diagnostic tests (CIDTs) without culture-confirmation, a number that has markedly increased since 2012 (*1*). Diagnostic testing practices for enteric pathogens are rapidly moving away from culture-based methods. The continued shift from culture-based methods to CIDTs that do not produce the isolates needed to distinguish between strains and subtypes affects the interpretation of public health surveillance data and ability to monitor progress toward prevention efforts. Expanded case definitions and strategies for obtaining bacterial isolates are crucial during this transition period.

FoodNet is a collaboration among CDC, 10 state health departments, the U.S. Department of Agriculture's Food Safety and Inspection Service (USDA-FSIS), and the Food and Drug Administration (FDA). FoodNet conducts active, population-based surveillance for laboratory-confirmed infections caused by *Campylobacter, Cryptosporidium, Cyclospora, Listeria, Salmonella*, Shiga toxin–producing *Escherichia coli* (STEC), *Shigella, Vibrio,* and *Yersinia* in 10 sites covering approximately 15% of the U.S. population (an estimated 49 million persons in 2014). Confirmed infections are defined as culture-confirmed bacterial infections and laboratory-confirmed parasitic infections (e.g., identified by enzyme immunoassay). Positive CIDT results are defined as the detection of antigen or nucleic acid sequences of the pathogen, or for STEC, Shiga toxin or the genes that encode a Shiga toxin, in a stool specimen or enrichment broth using a CIDT.† Positive CIDT results that were confirmed by culture are included only among the confirmed infections. For this analysis, the term "positive CIDT report" refers to positive CIDT results that were not confirmed by culture (either because the specimen was not cultured at the clinical or public health laboratory or because a culture did not yield the pathogen). Hospitalizations occurring within 7 days of specimen collection are recorded. The patient's vital status at hospital discharge, or 7 days after specimen collection if the patient was not hospitalized, is also captured. Hospitalizations and deaths that occur within 7 days of specimen collection are attributed to the infection.

Incidence of confirmed infections is reported for all FoodNet pathogens and calculated by dividing the number of confirmed infections in 2015 by U.S. Census estimates of the surveillance area population for 2014. A second incidence measurement, calculated by adding positive CIDT reports to confirmed infections, is also reported for *Campylobacter*, *Salmonella*, *Shigella*, and STEC.§ A negative binomial model with 95% confidence intervals (CIs) was used to estimate changes in incidence of infections in 2015 compared with 2012–2014. To describe changes in testing practices, percentage difference in number of positive CIDT reports was calculated for 2015 compared with 2012–2014, by pathogen.

Surveillance for physician-diagnosed postdiarrheal hemolytic uremic syndrome (HUS), a complication of STEC infection, is conducted through a network of nephrologists and infection preventionists and by hospital discharge data review. This report includes HUS data for persons aged <18 years for 2014, the most recent year for which data are available, and compares 2014 incidence with 2011–2013 incidence.

Cases of Infection, Incidence, and Trends

In 2015, FoodNet identified 20,107 confirmed cases of infection, 4,531 hospitalizations, and 77 deaths (Table 1). The number and incidence of confirmed infections per 100,000 population were reported for *Salmonella* (n = 7,728 [incidence = 15.89]), *Campylobacter* (6,309 [12.97]), *Shigella* (2,688 [5.53]), *Cryptosporidium* (1,612 [3.31]), STEC

* Connecticut, Georgia, Maryland, Minnesota, New Mexico, Oregon, Tennessee, and selected counties in California, Colorado, and New York (http://www.cdc.gov/foodnet).

† For STEC, only positive CIDT reports that were confirmed at the state public health laboratory were counted.

§ Incidence is reported for all STEC serogroups combined because it is not possible to distinguish between O157 and non-O157 based only on a CIDT test for Shiga toxin.

non-O157 (796 [1.64]), STEC O157 (463 [0.95]), *Vibrio* (192 [0.39]), *Yersinia* (139 [0.29]), *Listeria* (116 [0.24]), and *Cyclospora* (64 [0.13]). Among confirmed infections, the vast majority were diagnosed only by culture; the exception is STEC, for which most were identified by a CIDT (Table 2).

Among 6,827 (88%) serotyped *Salmonella* isolates, the top serotypes were Enteritidis, 1,358 (20%); Newport, 816 (12%); and Typhimurium, 739 (11%). Among 175 (91%) speciated *Vibrio* isolates, 113 (65%) were *V. parahaemolyticus*, 27 (15%) were *V. alginolyticus*, and 12 (7%) were *V. vulnificus*. Among 606 (76%) serogrouped STEC non-O157 isolates, the top serogroups were O26 (32%), O103 (27%), and O111 (18%).

Compared with incidence in 2012–2014, the 2015 incidence of confirmed infections was significantly higher for STEC non-O157 (40% increase; CI = 21%–62%), and *Cryptosporidium* (57% increase; CI = 20%–106%). No significant changes were observed in 2015 for other pathogens compared with the previous 3-year averages. Among the top three most commonly identified *Salmonella* serotypes, the incidence in 2015 compared with 2012–2014 was significantly lower for Typhimurium (15% decrease; CI = 4%–25%) and unchanged for Enteritidis and Newport.

FoodNet identified 55 cases of postdiarrheal HUS in children (0.50 cases per 100,000) in 2014; 30 (55%) occurred among children aged <5 years (1.01 cases per 100,000). Compared with 2011–2013, the incidence was significantly lower for all children (27% decrease; CI = 1%–46%) but no change for children aged <5 years was observed.

FoodNet also received 3,112 positive CIDT reports. The number of positive CIDT reports, by pathogen, were *Campylobacter* (2,021), *Shigella* (454), *Salmonella* (361), and STEC (254). These numbers represent an increase in positive CIDT reports in 2015 of 92% for *Campylobacter,* 284% for *Shigella*, 247% for *Salmonella,* and 120% for STEC, when compared with the 2012–2014 averages; the overall increase in CIDT reports for these four pathogens was 122%. Adding positive CIDT reports to confirmed cases resulted in the following incidence rates per 100,000 population: 17.12 for *Campylobacter*, 16.63 for *Salmonella*, 6.46 for *Shigella*, and 3.12 for STEC (Figure). Compared with 2012–2014, the 2015 incidence of confirmed infections plus positive CIDT reports was significantly higher for STEC but not for any other pathogen.

TABLE 1. Number of cases and incidence of confirmed infections,* hospitalizations, and deaths, by pathogen — Foodborne Diseases Active Surveillance Network, United States, 2015†

	Cases			Hospitalizations	Deaths
Pathogen	No.	Incidence§	Objective¶	No. (%)	No. (%)
Bacteria					
Campylobacter	6,309	12.97	8.5	1,065 (17)	11 (0.2)
Listeria	116	0.24	0.2	111 (96)	15 (12.9)
Salmonella	7,728	15.89	11.4	2,074 (27)	32 (0.4)
Shigella	2,688	5.53	—**	619 (23)	1 (0.0)
STEC O157	463	0.95	0.6	180 (39)	3 (0.6)
STEC non-O157	796	1.64	—**	126 (16)	1 (0.1)
Vibrio	192	0.39	0.2	47 (24)	5 (2.6)
Yersinia	139	0.29	0.3	37 (27)	1 (0.7)
Parasites					
Cryptosporidium	1,612	3.31	—**	268 (17)	8 (0.5)
Cyclospora	64	0.13	—**	4 (6)	0 (0.0)
Total	**20,107**	**NA**	**NA**	**4,531**	**77**

Abbreviations: NA = not applicable; STEC = Shiga toxin–producing *Escherichia coli*.
* Confirmed infections are defined as culture-confirmed bacterial infections and laboratory-confirmed parasitic infections.
† Data for 2015 are preliminary.
§ Per 100,000 population.
¶ *Healthy People 2020* objective targets for incidence of *Campylobacter*, *Listeria*, *Salmonella*, STEC O157, *Vibrio*, and *Yersinia* infections per 100,000 population.
** No national health objective exists for these pathogens.

TABLE 2. Number and incidence of confirmed infections and positive culture-independent diagnostic test (CIDT) reports, by pathogen, according to culture result — FoodNet, 2015*

	Confirmed infections†		Positive CIDT reports§		Confirmed infections and positive CIDT reports	
Pathogen	Culture-positive No. (%)	CIDT-positive and culture-positive No. (%)	CIDT-positive and culture-negative No. (%)	CIDT-positive and no culture No. (%)	No.	Incidence per 100,000 population
Campylobacter	5,964 (72)	345 (4)	851 (10)	1,170 (14)	8,330	17.12
Salmonella	7,354 (91)	374 (5)	141 (2)	220 (3)	8,089	16.63
Shigella	2,567 (82)	121 (4)	160 (5)	294 (9)	3,142	6.46
STEC¶	55 (4)	1,204 (80)	111 (7)	143 (9)	1,513	3.12
Vibrio	190 (95)	2 (1)	7 (3)	2 (1)	201	0.41
Yersinia	137 (90)	2 (1)	3 (2)	10 (7)	152	0.31
Listeria	116 (100)	0 (0)	0 (0)	0 (0)	116	0.23
Total	**16,383**	**2,048**	**1,273**	**1,839**	**21,543**	**NA**

Abbreviations: NA = not applicable; STEC = Shiga toxin–producing *Escherichia coli*.
* Data for 2015 are preliminary.
† Confirmed infections are defined as culture-confirmed bacterial infections and laboratory-confirmed parasitic infections.
§ Positive CIDT reports are defined as the detection of the enteric pathogen, or for STEC, Shiga toxin or the genes that encode a Shiga toxin, in a stool specimen or enrichment broth using a culture-independent diagnostic test. Any positive CIDT result that was confirmed by culture is counted only among the confirmed infections. For STEC, only positive CIDT reports that were confirmed at the state public health laboratory were counted.
¶ Excludes 197 Shiga toxin–positive reports from clinical laboratories that were Shiga toxin–negative at public health laboratory and 11 positive CIDT reports of detection of O157 antigen without testing for Shiga toxin.

Discussion

Use of CIDTs is finding cases that were not being previously diagnosed. Among confirmed cases, the incidence of *Cryptosporidium* and STEC non-O157 infections in 2015 was significantly higher than the average for the previous 3 years. The increase in incidence of STEC non-O157 infections is attributable, in part or in full, to increases in diagnostic testing (*2*). The proportion of laboratories testing for STEC non-O157 increased to 74% in 2015, compared with 55% in 2012 (FoodNet, unpublished data). The increase in *Cryptosporidium* follows the pattern observed in national data since 2005 and is likely also driven by increases in diagnostic testing (*3*,*4*).

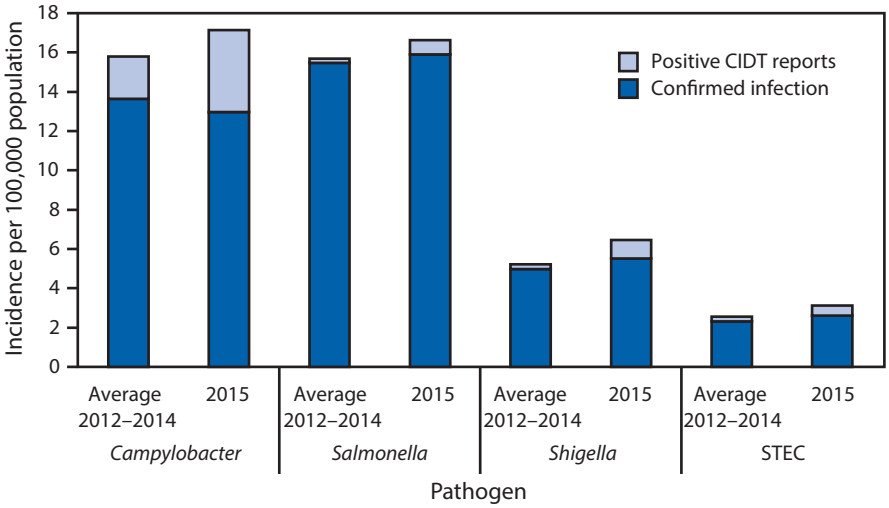
The incidence of *Salmonella* serotype Typhimurium infections continues to decline, and it has dropped to the third most commonly reported serotype. The use of a live attenuated Typhimurium vaccine in poultry (*5*), in addition to more stringent performance standards for *Salmonella* contamination of poultry carcasses (*6*) might have contributed to this decline. The significant decrease in HUS incidence in 2014 compared with the preceding 3 years (2011–2013) mirrors significant decreases in STEC O157 incidence observed during the same period (*7*). Efforts are still needed to decrease contamination of produce, beef, and other foods to achieve the *Healthy People 2020* goal for STEC O157 of 0.6 cases per 100,000 population.¶

The percentage of infections diagnosed only by CIDTs markedly increased in 2015. Diagnostic testing practices for enteric pathogens are rapidly moving away from culture-based methods, and the impact of this change varies by pathogen. Although CIDTs are still most commonly being used for *Campylobacter* and STEC, the highest percentage increase in use compared with the previous 3-year average was observed for *Shigella* and *Salmonella*, most likely due to laboratories using the newly available DNA-based syndrome panels (FoodNet, unpublished data)

In FoodNet, current methods to assess trends in the incidence of illness caused by bacterial pathogens are based only on culture-confirmed infections. The ability to assess and interpret change is impeded as the number of positive CIDT reports continues to rise because of important limitations in the understanding of CIDTs and possible changes in clinician and laboratory practices surrounding them. For example, analyses need to consider the likelihood of false-positive CIDTs and of CIDTs that are more sensitive than routine culture methods; such characteristics vary among CIDTs. The availability of CIDTs might also increase testing for some pathogens. Surveillance systems need to adapt to these changes by expanding case definitions to include positive CIDT reports. Isolates are still needed for antimicrobial susceptibility testing, serotyping, subtyping, and whole genome sequencing (*1*); these data are critical for monitoring trends, detecting clusters of illness, and investigating outbreaks. For *Salmonella*, with serotypes diverse in reservoirs and sources, the inability to distinguish serotypes will prevent tracking of important changes in incidence by serotype, and markedly limit detection and investigation of outbreaks. For STEC, because identification of serogroups requires culture, it is not known which STEC-positive CIDT reports represent O157 versus non-O157.

The findings in this report are subject to at least five limitations. First, increasing use of CIDTs by clinical laboratories might affect the number of culture-confirmed infections reported; use of CIDTs might result in an increase (as seen for STEC non-O157 infections) or decrease (as fewer cases might be diagnosed by traditional methods) in reported incidence. Second, the sensitivity and specificity of CIDTs vary by test type, brand, and other factors; some CIDT reports could be false positives (*1*). Third, health care–seeking behaviors, access to health services, and other characteristics of the population in the surveillance

FIGURE. Incidence of confirmed infections* and of positive culture-independent diagnostics test (CIDT) reports† that were not confirmed by culture for bacteria with more than 20 positive CIDT reports — Foodborne Diseases Active Surveillance Network, United States, 2012–2014§ and 2015¶,**



Abbreviation: STEC = Shiga toxin–producing *Escherichia coli*.

* Confirmed bacterial infections are defined as culture-confirmed.

† Positive CIDT reports are defined as the detection of the enteric pathogen, or for STEC, Shiga toxin or the genes that encode a Shiga toxin, in a stool specimen or enrichment broth using a culture-independent diagnostic test.

§ For 2012–2014, average incidence is reported.

¶ Data for 2015 are preliminary.

** Compared with 2012–2014, the 2015 incidence of confirmed infections plus positive CIDT reports was significantly higher for STEC but not for any other pathogen.

¶ https://www.healthypeople.gov/2020/topics-objectives/topic/food-safety/objectives.

Summary

What is already known about this topic?

The incidence of infections transmitted commonly by food has remained largely unchanged for many years. Multifaceted approaches involving public health, regulatory agencies, industry, and consumers are required to reduce the incidence.

What is added by this report?

Compared with average incidence in 2012–2014, in 2015, the incidence of *Cryptosporidium* and non-O157 STEC infections was higher and might, in part, be caused by the use of culture-independent diagnostic tests (CIDTs), which more than doubled during the comparison period.

What are the implications for public health practice?

Some information about the bacteria causing infections, such as subtype and antimicrobial susceptibility, can only be obtained if a CIDT-positive specimen is also cultured. Increasing use of CIDTs affects the interpretation of public health surveillance data and the ability to monitor progress towards prevention efforts. Currently, reflex culturing of specimens with positive CIDT reports should be considered for bacterial pathogens to obtain isolates needed for public health practice. In the long term, expedited research and development are needed to create methods to detect the genetic sequences of pathogens directly and rapidly from stool specimens, which could also benefit clinical and public health practice because subtype, resistance profile, and other features can be obtained from the genetic sequence.

area might affect the generalizability of the findings. Fourth, the proportion of illnesses transmitted by non-food routes differs by pathogen; data provided in this report are not limited to infections from food.** Finally, changes in incidence between periods can reflect year-to-year variation during those periods rather than sustained trends, and the number of infections and patterns observed might change as final data become available.

The use of CIDTs in clinical laboratories has many advantages. Illnesses can be diagnosed much faster than when culture is required. Also, some CIDTs are becoming available to detect infections caused by pathogens not routinely sought by standard laboratory methods. One of these is enterotoxigenic *E. coli,* an important cause of travelers' diarrhea (*8*).

More work is needed to extend the benefits of CIDT to the public health sector. During this initial period when clinical laboratories are transitioning to the use of CIDTs, reflex culturing†† of specimens with positive CIDT reports should be considered for bacterial pathogens to obtain isolates needed for public health practice. For the future, expedited research and development are needed to create methods to detect the genetic sequences of pathogens directly and rapidly from stool specimens, which has the potential to benefit both clinical and public health practice, because subtype, resistance profile, and other features can be obtained from the genetic sequence.

** FoodNet's data is used to support Interagency Food Safety Analytics Collaboration's projects to identify foods that are important sources of illnesses. http://www.cdc.gov/foodsafety/ifsac/index.html.

†† Reflex culturing for bacterial pathogens is culturing specimens with positive CIDT results

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Male-to-Male Sexual Transmission of Zika Virus — Texas, January 2016

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Zika virus infection has been linked to increased risk for Guillain-Barré syndrome and adverse fetal outcomes, including congenital microcephaly. In January 2016, after notification from a local health care provider, an investigation by Dallas County Health and Human Services (DCHHS) identified a case of sexual transmission of Zika virus between a man with recent travel to an area of active Zika virus transmission (patient A) and his nontraveling male partner (patient B). At this time, there had been one prior case report of sexual transmission of Zika virus (*1*). The present case report indicates Zika virus can be transmitted through anal sex, as well as vaginal sex. Identification and investigation of cases of sexual transmission of Zika virus in nonendemic areas present valuable opportunities to inform recommendations to prevent sexual transmission of Zika virus.

Epidemiologic Investigation

In January 2016, 2 days after returning to Dallas, Texas, from a 1-week visit to Venezuela, patient A developed subjective fever, pruritic rash on his upper body and face, and conjunctivitis lasting 3 days. Both 1 day before and 1 day after his symptom onset (Day 0), patient A had condomless insertive anal sex with patient B. Patient A reported that during and after illness he experienced no symptoms of prostatitis or dysuria, and noted no macroscopic hematospermia.

On Day 7, patient B developed a subjective fever, myalgia, headache, lethargy, and malaise; a few days later, he developed a slightly pruritic rash on his torso and arms, small joint arthritis of his hands and feet, and conjunctivitis. All symptoms resolved after 1 week. On Day 11, while still symptomatic, patient B visited his primary care provider for evaluation. Suspecting Zika virus infection, the provider obtained serum specimens from patient B on Day 11 (4 days after patient B's illness onset), and from both patients A and B on Day 14 (14 and 7 days after respective illness onsets). On Day 24, semen, urine, and saliva specimens were collected from both patients (24 and 17 days after respective illness onsets).

Patient A had traveled regularly to Central and South America for many years. During his recent trip to Venezuela, he reported that multiple persons in the area he visited were experiencing symptoms consistent with Zika virus disease; autochthonous transmission of Zika virus had been confirmed in Venezuela in late November 2015.* Patient B had not recently traveled outside of the United States and had never traveled to countries with active autochthonous Zika transmission. Neither patient had a history of prior known arboviral infection nor had they received yellow fever or Japanese encephalitis vaccinations. The men had been mutually monogamous for more than 10 years and had no major medical illnesses or history of sexually transmitted infections. Neither patient reported ulcerative anal or genital lesions.

Laboratory Investigation

Samples of all clinical specimens were sent by DCHHS to CDC. Patient A's serum from 14 days after illness onset and patient B's serum from 4 days after illness onset contained no detectable Zika virus RNA using reverse transcription polymerase chain reaction (RT-PCR) testing (Table) (*2*). Sera from both patients demonstrated positive immunoglobulin M (IgM) responses by capture ELISA for Zika virus and dengue virus, but not for chikungunya virus (Table) (*2*). Plaque-reduction neutralization tests (*3*) indicated that patient A had been infected with Zika virus, dengue virus serotype 1, or both, but that patient B had been infected only with Zika virus. Urine and saliva specimens collected from patients A and B at 24 and 17 days after respective illness onsets had no detectable Zika virus by RT-PCR.

* Pan American Health Organization and World Health Organization Regional Office of the Americas. Epidemiological alert. Neurological syndrome, congenital malformations, and Zika virus infection. Implications for public health in the Americas — 1 December 2015.

TABLE. Reverse transcription polymerase chain reaction (RT-PCR) and serologic testing of serum from patients A and B — Texas, January 2016

Patient	Days after symptom onset	ZIKV RT-PCR	ZIKV IgM*	DENV IgM	CHIK IgM	ZIKV PRNT†	DENV-1 PRNT†	DENV-2 PRNT†
Patient A	14	Negative	Positive	Positive	Negative	>20,480	>20,480	5,120
Patient B	4	Negative	ND	ND	ND	160	<10	<10
Patient B	7	Negative	Positive	Positive	Negative	2,560	10	<10

Abbreviations: CHIKV = chikungunya virus; DENV-1 or 2 = dengue virus serotype type 1 or 2; IgM = immunoglobulin M; ND = not done; PRNT = plaque-reduction neutralization test; ZIKV = Zika virus.
* IgM antibody capture-enzyme linked immunosorbent assay.
† Serum dilution-plaque reduction neutralization test, titers of neutralizing antibodies to ZIKV, DENV-1, and DENV-2.

Semen specimens collected at 24 and 17 days from each man were tested for Zika virus by RT-PCR both by CDC and DCHHS using the same two sets of primers (*2*). At CDC, neither sample had detectable Zika virus with either primer set after 37 cycles. At DCHHS, which pretreated the thawed semen samples with dithiothreitol (used to induce liquefaction of viscous specimens and potentially increase detection of RT-PCR targets), patient B's specimen was negative. Patient A's specimen had Zika virus detected at 35 cycles with one primer set but produced no signal after 37 cycles with the other primer set. Patient A's semen results were thus deemed equivocal.

Environmental Investigation

Although Dallas is within the geographic range of the Zika virus mosquito vectors *Aedes aegypti* and *Ae. albopictus*, seasonal winter temperatures in the area during the week of the traveler's return were not permissive for *Aedes* activity. Maximum area temperatures during the week of the traveler's return were <12°C (<54°F)[†] and thus not suitable for overwintering *Aedes* eggs to hatch and resulting larvae to survive. BG-Sentinel (Biogents AG, Regensberg, Germany) and gravid mosquito traps placed around the residential areas of patients A and B in January yielded only *Culex* but no *Aedes* mosquitoes.

Discussion

In addition to the present case report, at least five other cases of sexually transmitted Zika virus infection supported by laboratory evidence have now been reported in the published literature; all were male-to-female transmissions involving vaginal sex. All of the male travelers had symptoms consistent with Zika virus infection and could have transmitted infections to their sex partners a few days before or after as well as during the time symptoms appeared (*3*–*5*). In this case report, patient B's potential exposures occurred both before and just after initial appearance of symptoms in the traveler, which is the time when blood viremia appears to be highest (i.e., as clinical signs and symptoms of infection emerge).[§]

Transmission of Zika virus to patient B by *Ae. aegypti* or *albopictus* was unlikely based on environmental conditions. Even if these mosquito species had been present and active, the time from exposure to illness in patient B (i.e., 6–8 days) was shorter than the minimum estimated time required for *Aedes* to become infectious had a mosquito ingested a Zika virus-infected blood meal from patient A (i.e., *Ae. aegypti* extrinsic incubation period is a minimum estimated duration of 10 days) (*6*,*7*), and for patient B once infected to have then developed illness (i.e., 3–12 days).

Studies investigating seminal shedding of infection-competent Zika virus, including its incidence, pattern (e.g., intermittent shedding or a steady decay), and duration are ongoing. At the time of Patient B's clinical presentation, there had been only one published report describing testing of semen from a man with Zika virus infection (*8*); studies of semen from two additional men have since been reported (*9*,*10*). Zika virus has been detected by RT-PCR and isolated in culture from the semen of two men at least 2 weeks after onset of illnesses (*8*,*10*) and possibly up to 10 weeks after illness in one of these cases (*8*). One report described Zika virus detectable in semen by RT-PCR 62 days after illness onset; culture was not performed (*9*). In two men, Zika virus was no longer detectable in their blood by RT-PCR when the semen specimens were analyzed (*8*,*9*). None of the three men provided follow-up semen specimens to determine when Zika virus was no longer detectable. Notably, all men in the five case reports and the three semen studies, as well as patient A, experienced symptomatic illness. In the report of the sexual transmission case that occurred in 2008 (*1*) and of the man with culturable Zika virus in semen in 2013 (*8*), symptoms also included hematospermia.

Identifying and characterizing cases of sexually transmitted Zika virus infection in areas experiencing intense autochthonous vector-borne Zika virus transmission is challenging. Reports of sexual transmission identified in areas where autochthonous transmission is not occurring offer unique and important opportunities to learn about this emerging mode of transmission and rapidly inform and refine interim prevention recommendations. Such cases highlight the need for clinicians to remain vigilant for and continue reporting any suspected cases of Zika virus infection to their state or

Summary

What is already known about this topic?

Although Zika virus is spread primarily by *Aedes* species mosquitoes, published case reports have documented sexual transmission from infected men to their female sex partners through vaginal sex.

What is added by this report?

This is the first report of transmission of Zika virus from an infected man to a sex partner through anal sex.

What are the implications for public health practice?

Sexual transmission through both vaginal and anal sex is an emerging mode of Zika virus infection that might contribute to more illness than was anticipated when the outbreak was first recognized. Cases of sexually transmitted Zika virus infection should be reported to public health agencies and can help inform recommendations to prevent Zika virus infections.

[†] National Weather Service Climate Prediction Center. Temperature data for Dallas-Ft. Worth, Texas. 2016. http://www.cpc.ncep.noaa.gov/products/tanal/temp_analyses.php.

[§] http://www.who.int/bulletin/online_first/16-171207.pdf.

local health departments, including suspected infections in symptomatic persons without travel history, but who report unprotected sexual contact with a person who has traveled to an area with active Zika virus transmission.

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Survey of Blood Collection Centers and Implementation of Guidance for Prevention of Transfusion-Transmitted Zika Virus Infection — Puerto Rico, 2016

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On April 8, 2016, this report was posted as an MMWR *Early Release on the* MMWR *website (http://www.cdc.gov/mmwr).*

Since November 2015, Puerto Rico has reported active mosquito-borne transmission of Zika virus (*1*). Because of the potential for Zika virus to be transmitted through transfusion of blood components, and because a high percentage of persons infected with Zika virus are asymptomatic (*2*), the Food and Drug Administration (FDA) recommended that blood collections cease in areas of the United States affected by active vector-borne transmission of Zika virus until laboratory screening of blood donations or pathogen reduction technology (PRT)* for treatment of blood components can be implemented (*3*). To inform efforts to maintain the safety and availability of the blood supply in Puerto Rico, CDC, in collaboration with the Puerto Rico Department of Health, conducted a rapid assessment of blood collection and use on the island. A total of 139,369 allogeneic red blood cell (RBC) units,† 45,243 platelet units, and 56,466 plasma units were collected in or imported to Puerto Rico during 2015, and 135,966 allogeneic RBC units, 13,526 therapeutic platelet units,§ and 25,775 plasma units were transfused. Because of the potential for local Zika virus transmission in areas with a competent mosquito vector (*4*), other areas of the United States should develop plans to ensure local blood safety and adequacy. Blood collection organizations and public health agencies should collaborate to maintain the safety and availability of local blood supplies in accordance with FDA guidance.

Before this survey, no estimates of blood collection and use in Puerto Rico were available. The survey, conducted during February 10–24, 2016, included all blood collection centers performing local collections and importing blood components from the mainland United States for routine clinical use, as well as hospitals performing transfusions in Puerto Rico during 2015. The survey was based on a modified version of the 2015 National Blood Collection and Utilization Survey administered by CDC on behalf of the U.S. Department of Health and Human Services (*5*), in which U.S. territories have previously not been included. The survey included questions about donor blood collection methods and product types, importation of blood products for routine use, blood use, and extent of PRT implementation for platelets and plasma. Questionnaires were electronically distributed to the laboratory manager or medical director of each facility and were self-administered. Total collections and transfusions of whole blood, whole blood derived (WBD) RBC, platelet, plasma, and cryoprecipitate units (including total numbers of blood components imported from the continental United States), as well as RBC, platelet, and plasma units collected via apheresis¶ methods were tabulated. Estimates of transfusion were weighted for nonresponse using inpatient surgical volume (the average number of surgical procedures performed annually at a hospital) as a proxy for the amount of blood used annually, and 95% confidence intervals were estimated.

All 12 (100%) blood collection centers and 51 (91.1%) of 56 hospitals performing transfusions responded to the survey. During 2015, a total of 82,381 whole blood units were reported to have been collected in Puerto Rico. These whole blood units yielded WBD components, including 80,431 allogeneic RBC units, 32,753 individual platelet units, 47,055 plasma units, and 4,615 cryoprecipitate units. RBCs, platelets, and plasma collections using apheresis methods were reported in much fewer numbers than those derived from whole blood (Table 1). PRT was used only to treat apheresis platelets, and constituted 1,403 (25.6%) of the 5,467 apheresis platelet collections. An additional 52,411 RBC units, 7,023 apheresis platelet units, 7,906 plasma units, and 2,651 cryoprecipitate units were imported from the continental United States for routine use in 2015. A total of 135,966 allogeneic RBC units, 13,526 therapeutic platelet units, and 25,775 plasma units were transfused in 2015 (Table 2). Only 511 (36.4%) of the 1,403 PRT-treated platelet units were transfused by hospitals in 2015.

Discussion

No blood transfusion-transmitted cases of Zika virus infection have been confirmed in Puerto Rico or the U.S. mainland (*4*); however, Zika virus nucleic acid was detected

* Chemical and/or ultraviolet light treatment to achieve reduction of risk for transfusion-transmitted infection. PRT is currently approved by the Food and Drug Administration (FDA) only for plasma and platelets derived from apheresis methods. It is not FDA-approved for red blood cells.

† Allogeneic blood components are collected from donors for transfusion into another person.

§ A unit of platelets prepared for transfusion from pooled individual whole blood derived platelet units.

¶ A medical technology that involves the withdrawal of blood from a donor, removal of one or more blood components (e.g., plasma or platelets), and transfusion of the remaining blood back into the donor.

retrospectively in 2.8% of asymptomatic blood donors during a 2013–2014 Zika virus disease outbreak in French Polynesia (*6*), and transfusion-transmitted Zika virus infection has been reported in Brazil (*7*), where substantial Zika virus transmission is occurring. Because a large percentage of persons infected with Zika virus are asymptomatic (*2*), the risk for transfusion-transmitted Zika virus infection in Puerto Rico and other areas of the United States and its territories is of concern.

In Puerto Rico, the majority of whole blood units and blood component units collected during 2015 were collected locally, placing a large proportion of the local blood supply at potential risk for transfusion-transmitted Zika virus infection. Whereas PRT is FDA-approved for plasma and apheresis platelets, and could be used to treat portions of the blood supply in accordance with FDA guidance, a lower than expected proportion of the platelet supply was derived from apheresis methods in Puerto Rico compared with the continental United States, where in 2013, 95% of all platelets were collected via apheresis (*5*); this difference might have been related to cost of implementation of apheresis methods in Puerto Rico. In addition, PRT is not FDA-approved for whole blood or RBCs, the most commonly transfused WBD component. These factors resulted in a risk for critical blood shortages as local blood collections in Puerto Rico were recommended to cease on March 1, 2016, in accordance with FDA guidance, until a nucleic acid screening test could be implemented for blood collections under investigational protocols beginning on April 4, 2016 (*8*).

The results of this survey were used to guide a federally supported coordinated effort to address the blood supply and safety challenges in Puerto Rico, which included importation of all blood components from the continental United States at a volume sufficient to meet the demand projected from the 2015 estimates, beginning on March 5, 2016 (*9*). Local collections resumed in Puerto Rico on April 2, 2016, after FDA approved blood donations in the United States to be screened for Zika infection using an investigational nucleic acid test developed by Roche Molecular Systems (Branchburg, New Jersey) (*8*). In addition, efforts to implement PRT for apheresis platelets and plasma collections in Puerto Rico are currently under way, and evaluation trials to determine safety and efficacy of investigational PRT for RBCs are in planning stages.

The findings in this report are subject to at least three limitations. First, survey data were self-reported by facilities and could not be independently verified. Second, although the survey response rate was high, results were limited by missing responses to some questions, leading to uncertainty regarding the estimates. Finally, although English language assistance was available to respondents, each of whom was contacted directly by a Spanish-speaking team member to ensure receipt of the survey and inquire about the need for assistance, the survey instrument was written in English, which might have affected the interpretation of questions by staff members in blood collection centers and hospitals; the impact on the survey findings is not known.

TABLE 1. Number of units of blood and blood components collected by all 12 of the country's blood collection centers or imported from the continental United States for routine clinical use — Puerto Rico, 2015

Component type	No. of units collected	No. of units imported	Total units
Whole blood collections	**82,381**	**0**	**82,381**
Red blood cells (RBCs)			
Apheresis* RBCs	5,280	16,575	21,855
Allogeneic WBD RBCs	80,431	35,836	116,267
Autologous WBD RBCs	396	0	396
Directed WBD RBCs	851	0	851
Total RBC collections	**86,958**	**52,411**	**139,369**
Platelets			
Apheresis platelets	5,467	7,023	12,490
Apheresis platelets prepared using pathogen reduction technology (PRT)†	1,403	0	1,403
Individual WBD platelets§	32,753	0	32,753
Total platelet collections	**38,220**	**7,023**	**45,243**
Plasma			
Apheresis plasma	1,505	2	1,507
WBD plasma	47,055	7,904	54,959
Total plasma collections	**48,560**	**7,906**	**56,466**
Plasma prepared using PRT	0	0	0
Other			
Individual cryoprecipitate	4,615	2,651	7,266

Abbreviation: WBD = whole blood derived.

* A medical technology that involves the withdrawal of blood from a donor, removal of one or more blood components (e.g., plasma or platelets), and transfusion of the remaining blood back into the donor.

† Chemical and/or ultraviolet light treatment to achieve reduction of risk for transfusion-transmitted infection. PRT is currently approved by the Food and Drug Administration (FDA) only for plasma and platelets derived from apheresis methods. It is not FDA-approved for red blood cells.

§ WBD platelets were reported as individual units. These units are pooled to result in a standard adult dose. The average pool size for whole blood derived platelets was 5.8 individual doses.

The risk for transfusion-transmitted Zika virus infection presents a current challenge to the safety and availability of the blood supply in Puerto Rico and an emerging threat to other areas of the United States, where Zika virus might spread via mosquito-borne transmission, particularly given the risk for clinical complications associated with infection, including Guillain-Barré syndrome and congenital abnormalities in infants born to women infected during pregnancy (*10*). Because of the high rate of asymptomatic infection (*2*), blood donor screening without a laboratory test is insufficient for identifying infected donors in areas with active transmission. Interventions to prevent transfusion-transmitted Zika virus infection in areas of the United States that do not have active

TABLE 2. Weighted estimates of the number of units of blood and blood components transfused and number of hospitals (N = 56) responding to the survey — Puerto Rico, 2015

Component type	No. of units transfused*	No. of hospitals responding	(95% CI)
Whole blood units			
Allogeneic†	0	27	—
Directed§	0	28	—
Autologous¶	22	28	(0–68)
Red blood cells			
Allogeneic	135,966	47	(110,856–161,075)
Directed	2,338	32	(0–6,288)
Autologous	357	36	(29–684)
Platelets			
Whole blood derived (WBD**)	22,054	31	(4,768–39,339)
Apheresis†† platelets	9,724	44	(5,590–13,857)
Apheresis platelets prepared using pathogen reduction technology (PRT)§§	511	44	(0–1,278)
Plasma			
Total	25,775	46	(15,935–35,615)
Plasma prepared using PRT	0	23	—

Abbreviation: CI = confidence interval.

* Weighted for nonresponse in a population of 56 hospitals.

† Collected from donors for transfusion into another person.

§ Donations intended for a specific recipient.

¶ Donations by individuals for their own use, often for an elective procedure or planned transfusion.

** WBD platelets were reported as individual units. These units are pooled to result in a standard adult dose. The average pool size for whole blood derived platelets was 5.8 individual doses.

†† A medical technology that involves the withdrawal of blood from a donor, removal of one or more blood components (e.g., plasma or platelets), and transfusion of the remaining blood back into the donor.

§§ Chemical and/or ultraviolet light treatment to achieve reduction of risk for transfusion-transmitted infection. PRT is currently approved by the Food and Drug Administration (FDA) only for plasma and platelets derived from apheresis methods. It is not FDA-approved for red blood cells.

mosquito-borne transmission include donation deferral for those who have had Zika virus infection (deferral for 4 weeks after symptom resolution) or symptoms suggestive of Zika virus infection during the past 4 weeks, those who have had sexual contact with a person with Zika virus infection or who has traveled to, or resided in, an area with active Zika virus transmission during the prior 3 months, and those who have traveled to areas with active transmission of Zika virus during the past 4 weeks (*3*). In areas with current mosquito-borne Zika virus transmission, importation of blood components from unaffected areas is recommended until nucleic acid testing is implemented or PRT, as applicable, is adopted.

Outsourcing of blood components from unaffected areas might not be feasible if there is widespread Zika virus transmission in heavily populated areas of the continental United States. Therefore, it is important to maintain local blood collections in the continental United States. The availability of safe blood is a critical need for health care, and collaboration between blood collection organizations and health departments is essential to comply with FDA guidance, including implementation of laboratory testing of blood donations or use of PRT with plasma units and apheresis platelets.

Summary

What is already known about this topic?

Because of the potential for transfusion-associated transmission of Zika virus, the Food and Drug Administration (FDA) has recommended deferral of blood donors in affected U.S. areas until blood donations can be screened by nucleic acid testing or blood products can be subjected to FDA-approved pathogen reduction technology (PRT). FDA has recommended that whole blood and blood components for transfusion be obtained from U.S. areas without active Zika virus transmission.

What is added by this report?

Puerto Rico is experiencing active Zika virus transmission and also performs local blood collections. Therefore, Puerto Rico is the first U.S. area to need to comply with FDA guidance. Historically, Puerto Rico has also imported blood from the U.S. mainland for routine purposes. Outsourcing of blood components from unaffected areas might not be feasible if there is widespread Zika virus transmission in heavily populated areas of the continental United States. Therefore, local blood collections should be maintained through the use of nucleic acid screening or PRT.

What are the implications for public health practice?

Importation of blood products from nonaffected areas might serve a role in prevention of transfusion-transmitted Zika virus. An approved laboratory test for blood donor screening and implementation of PRT are critical for compliance with FDA guidance and to ensure a safe and sustainable blood supply. Blood collection organizations and public health organizations need to collaborate to prepare for blood safety and adequacy challenges that might arise if Zika virus transmission spreads in the United States.

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Notes from the Field

Outbreak of Multidrug-Resistant *Salmonella* Infections Linked to Pork — Washington, 2015

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During June–July 2015, Public Health–Seattle & King County (PHSKC) and Washington State Department of Health (WADOH) investigated 22 clusters of *Salmonella* serotype I 4,[5], 12:i:- infections. Serotype I 4,[5], 12:i:- is the fifth most frequently reported *Salmonella* serotype in the United States, but is uncommon in Washington.* On July 29, 2015, WADOH and PHSKC requested assistance from CDC to identify the infection source, determine risk factors, and make recommendations for prevention.

A confirmed case was initially defined as a gastrointestinal illness with onset during April 25–September 25, 2015, with documentation of a *Salmonella* serotype I 4,[5], 12:i:- isolate from one of five closely related pulsed-field gel electrophoresis (PFGE) *Xba*I patterns (JPXX01.1314, JPXX01.2311, JPXX01.2429, JPXX01.3161, or JPXX01.3336) in a Washington resident, or with an isolate matching one of the outbreak PFGE patterns with highly related whole genome sequencing, in a non-Washington resident. Later in the investigation, an additional PFGE *Xba*I pattern (JFXX01.0046) was added to the case definition.

A total of 192 confirmed cases were reported from five states; 184 (96%) occurred in Washington (Figure). Patients ranged in age from <1 to 90 years (median = 35 years), and 97 (51%) were female. Among 180 patients for whom information about hospitalization was available, 30 (17%) were hospitalized; no deaths were reported.

On the basis of cases investigated before August 2015, a supplemental questionnaire that went into more detail in addressing meat and livestock exposures was developed. Among 80 patients (42% of all confirmed cases) who were interviewed, 59 (74%) reported eating pork during the 7 days preceding illness. This was significantly higher than the most recently published (2007) Foodborne Diseases Active Surveillance Network (FoodNet) population survey of healthy persons, in which 43% reported eating pork in the week before they were interviewed (p <0.001) (*1*).

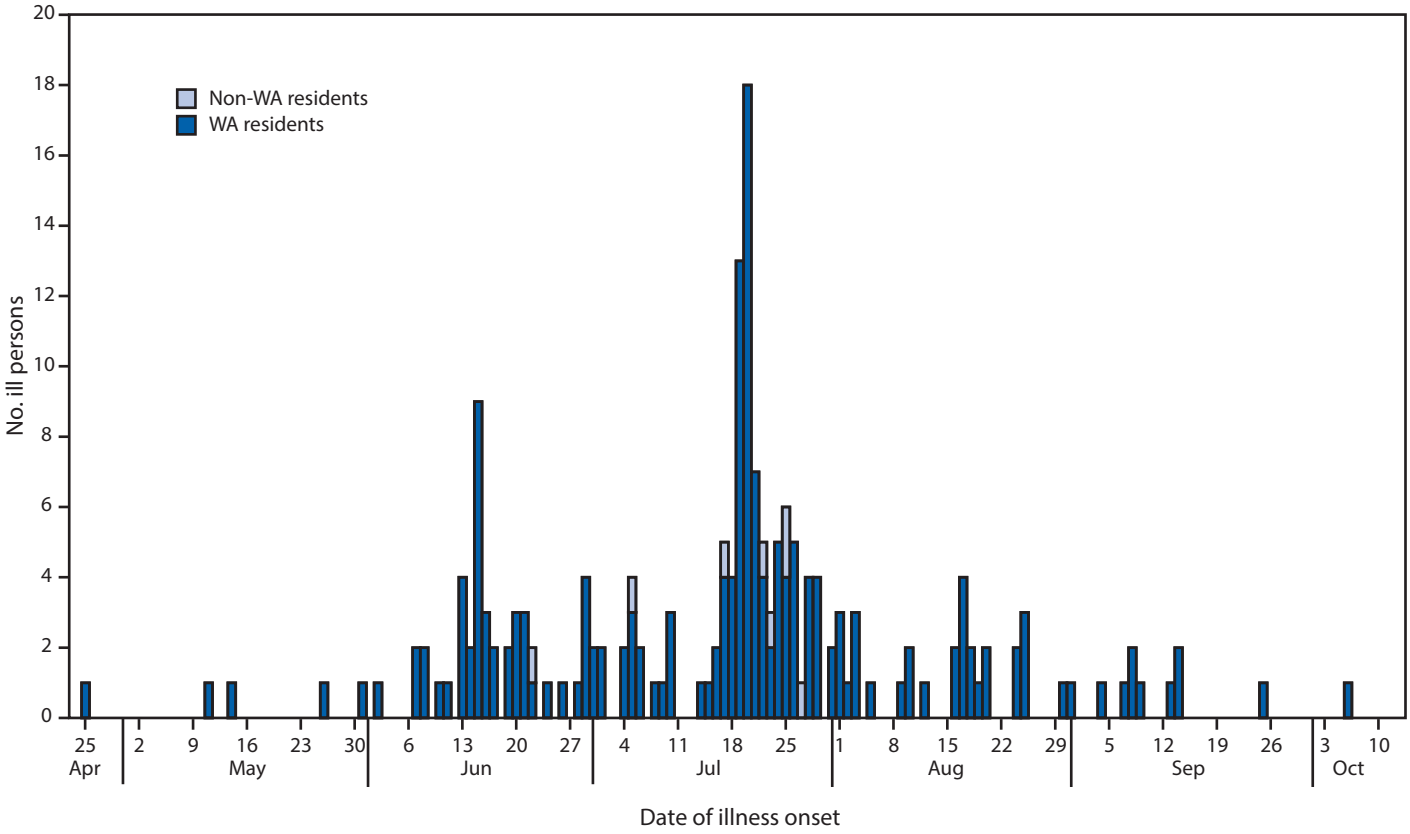
WADOH and PHSKC investigation into the source of pork traced the pork consumed by 35 (59%) of the 59 interviewed patients who reported eating pork back to a U.S. Department of Agriculture's Food Safety and Inspection Service–inspected pork slaughter establishment in Graham, Washington. During the outbreak period, the establishment distributed whole hogs and pork parts, primarily from five farms in Montana and one in Washington, to Washington, Oregon, and Alaska. Among the 21 interviewed patients who did not report consuming pork before becoming ill, 13 had eaten at one of two restaurants or had shopped at one market where pork from the establishment was served. During June and July 2015, PHSKC inspections of these three facilities identified potential opportunities for cross-contamination of raw pork with other meat and produce, including inadequate employee handwashing and insufficient cleaning and sanitization of food contact surfaces and utensils used for raw meat. Food and environmental sampling by PHSKC at all three facilities yielded the outbreak strains.

Eight of 11 pooled environmental samples collected on July 31, 2015, from the slaughter establishment by WADOH yielded one of the outbreak strains. A parallel Food Safety and Inspection Service investigation of the establishment, conducted during August 10–14, cited insanitary conditions, supported by isolation of outbreak strains from samples taken before the start of daily operations, consistent with WADOH results. Additionally, the Food Safety and Inspection Service isolated *Salmonella* Infantis (*Xba*I pattern JFXX01.0046) from the establishment, which was subsequently added to the case definition. Four patients (2% of all confirmed cases) were identified using the updated case definition. On August 13, 2015, the establishment recalled an estimated 116,262 pounds of whole hogs produced during April 18–July 27, and on August 27, expanded the recall to include approximately 523,380 pounds of pork products produced during April 18–August 26 because of potential contamination with *Salmonella* I 4,[5], 12:i:- (*2*). On August 27, the slaughter establishment voluntarily ceased operations.

Ten clinical isolates of the outbreak strains from Washington were submitted to CDC's National Antimicrobial Resistance Monitoring System for resistance testing. All 10 exhibited resistance to ampicillin, streptomycin, sulfisoxazole, and tetracycline (ASSuT resistance). In 2009, the National Antimicrobial Resistance Monitoring System reported <1.5% of *Salmonella* I 4,[5], 12:i:- human isolates had the ASSuT resistance pattern; in 2013, this number had increased to 45.5% (*3*). Regarding future *Salmonella* I 4,[5], 12:i:- outbreaks,

* National Enteric Disease Surveillance: *Salmonella* Annual Report, 2012. http://www.cdc.gov/ncezid/dfwed/pdfs/salmonella-annual-report-2012-508c.pdf.

FIGURE. Date of illness onset* among 192 persons† infected with the outbreak strains of *Salmonella* I 4,[5], 12:i:- or *S.* Infantis, by state residency status — Washington, 2015



Abbreviation: WA = Washington.
* When unknown, illness onset dates were estimated by the following formula: (isolation date of outbreak strains of *Salmonella* I 4,[5], 12:i:- or *S.* Infantis) – 3 days.
† N = 192 for whom information was reported as of November 24, 2015.

increasing ASSuT resistance is concerning because infections with antimicrobial-resistant *Salmonella* strains are associated with an increased risk for hospitalization, bloodstream infection, and treatment failure (*4*,*5*). Further study of the epidemiology and etiology of ASSuT resistance and *Salmonella* I 4,[5], 12:i:- is recommended.

This was the largest *Salmonella* outbreak in Washington in recent history, and highlights that pork is an important source for human *Salmonella* infections (*6*). Best practices in all parts of the pork production industry, from farm to processing plant, can help reduce the risk for future outbreaks (*7*). In addition, prevention strategies that include rigorous *Salmonella* control in pork slaughter establishments in conjunction with food handling education at the wholesaler and restaurant level should be strengthened.

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Notes from the Field

Health Care–Associated Outbreak of Epidemic Keratoconjunctivitis — West Virginia, 2015

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On September 4, 2015, the West Virginia Bureau for Public Health (WVBPH) was notified by an urban ophthalmology practice of 13 patients with epidemic keratoconjunctivitis (EKC) diagnosed during the preceding 3 weeks. EKC is an eye infection characterized by severe inflammation of the conjunctiva and cornea, and can result in vision loss (*1*). Pathogens commonly detected in EKC outbreaks are human adenovirus (HAdV) serotypes 8, 19, and 37, which are spread person-to-person or by fomites; no vaccines or effective antiviral treatments are available (*2*). HAdVs that cause EKC are resistant to desiccation and certain common surface disinfectants (*3*). Incubation periods of approximately 14 days, prolonged viral shedding, and persistence of live virus on some surfaces for up to 30 days (*3*) hamper outbreak prevention and control efforts. EKC often occurs simultaneously in health care settings and the community (*2*). EKC is not a reportable disease and outbreak reporting is often delayed (*2*); the incidence in West Virginia is unknown.

The local health department, with support from WVBPH, conducted an investigation to determine the source, identify additional cases, and implement control measures. An EKC case was defined as an ophthalmologist-diagnosed acute nonbacterial eye disease, characterized by conjunctival inflammation and lacrimation with ≥2 of the following symptoms: foreign body sensation, light sensitivity, eye pain, or conjunctival edema. A practice-associated EKC case was defined as a case of EKC diagnosed in a person who visited the ophthalmology practice or who lived with a patient who visited the practice ≤14 days before symptom onset. Practice-associated cases were ascertained by medical record review. A local health advisory was released to increase case-finding; symptomatic patients not associated with the practice were interviewed by telephone to ascertain symptoms and determine case status. By September 14, an additional 10 cases had been reported; eight were practice-associated, including two in practice staff members; two cases were in patients not previously associated with the practice.

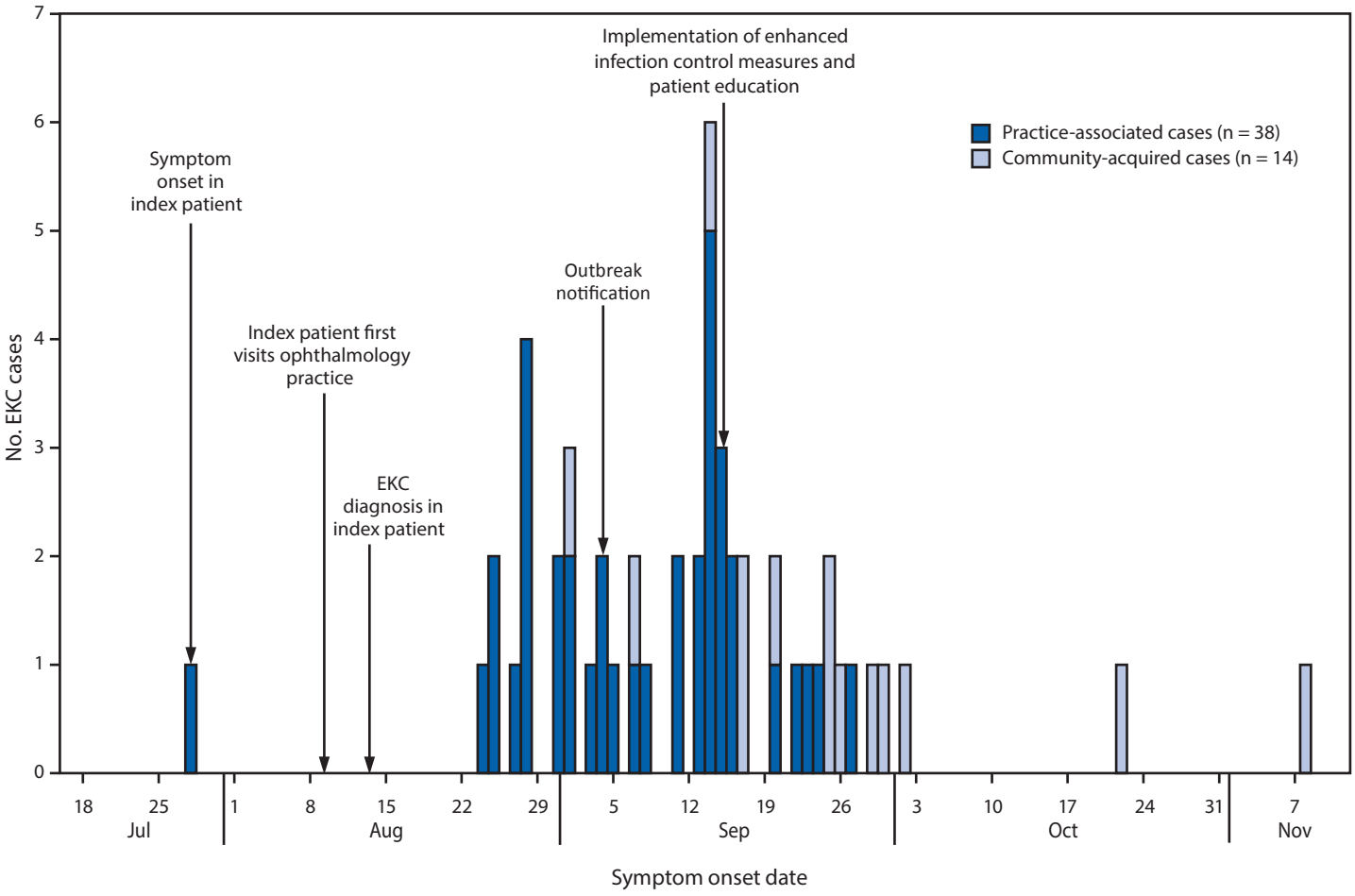
Laboratory testing for HAdV was established on September 5. Fifteen patient conjunctival swab specimens were collected from symptomatic patients at the practice during September 5–October 5, and stored by a regional hospital virology laboratory. Site visits were conducted by the local health department on September 10 and September 15; seven environmental swab samples were collected during the September 15 site visit. The Wadsworth Laboratory, New York State Department of Health, confirmed HAdV presence with real-time polymerase chain reaction, and performed HAdV molecular serotyping on the first 12 conjunctival swab specimens collected and on the seven environmental samples. HAdV-8 was detected in 10 of 12 patient specimens; HAdV-3 was detected in one; and one specimen had no detectable virus. HAdV-8 was also detected in three of the seven environmental samples; these were recovered from an exam chair hand rest, a slit lamp chin rest, and an applanation tonometer (a device used to measure intraocular pressure) in a single examination room.

Infection control procedures identified during site visits included an unwritten protocol of once daily cleaning of commonly touched surfaces, and wiping instruments with alcohol pads after each patient contact. The local health department recommended a written infection control policy using cleaning agents effective against HAdV contamination (*3*), cleaning all touched surfaces between symptomatic patient encounters, segregating infectious patients from others, mandatory leave for symptomatic staff members, and patient education regarding EKC transmission prevention. Control recommendations were implemented on September 15.

During August 14–December 1, a total of 52 EKC cases were identified, with symptom onset July 28–November 8. Overall, 38 (73%) cases were practice-associated (Figure). Laboratory confirmation of HAdV-8 among practice-associated cases and HAdV-8 contaminating the practice environment suggest that health care–associated transmission occurred during the 1 month between the first EKC diagnosis and implementation of control measures.

This investigation highlights the importance of effective control measures for HAdV decontamination in health care settings to prevent transmission within clinical settings and the community. Eye care providers should maintain written infection control protocols addressing EKC, and other infection risks, as recommended by CDC (*4*). Timely reporting of outbreaks and deployment of an EKC outbreak toolkit that includes patient education, a health advisory to providers, and a chart abstraction template, might reduce transmission; a toolkit is available upon request to WVBPH, Division of Infectious Disease Epidemiology.

FIGURE. Dates of symptom onset in 52 patients with epidemic keratoconjunctivitis (EKC) and outbreak-related activities — West Virginia, July–November, 2015



Acknowledgments

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Announcement

National Infant Immunization Week — April 16–23, 2016

National Infant Immunization Week (NIIW), April 16–23, 2016, will focus attention on the role of immunization in protecting infants from vaccine-preventable diseases. When NIIW was established approximately 20 years ago, immunization programs were facing significant challenges. The nation was in the midst of a serious measles outbreak, and communities across the United States were experiencing decreasing immunization rates among children.

Since 1994, hundreds of communities across the country have joined together each year during NIIW to promote infant immunization. Although immunization coverage among children has increased, recent outbreaks of measles in the United States underscore the importance of maintaining high immunization rates in every community.

During NIIW, local and state health departments, national immunization partners, and health care professionals will conduct parent outreach, clinician education activities, and other events to highlight the positive impact of vaccination on the lives of infants and to call attention to immunization achievements. To support these efforts, various promotional and educational materials are available from CDC on the NIIW website (www.cdc.gov/vaccines/events/niiw/).

The United States celebrates NIIW in conjunction with World Immunization Week (April 24–30), the World Health Organization's initiative to promote and advance equity in the use of vaccines. The recipients of the annual CDC Childhood Immunization Champion Award, which recognizes local contributions to public health through work in childhood immunizations, will be announced during NIIW.

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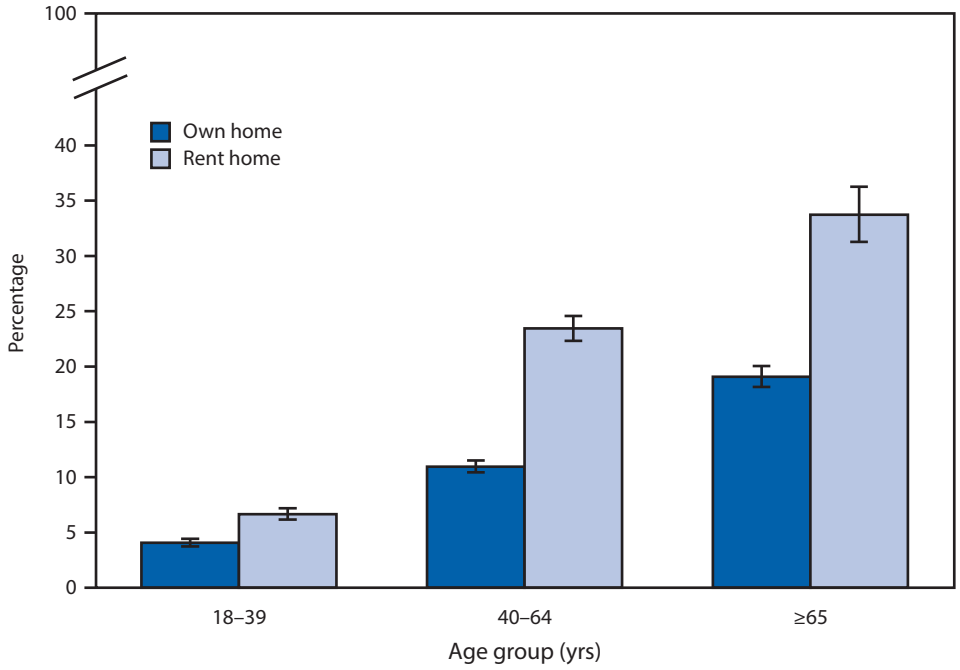
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Adults with Fair or Poor Health,† by Home Ownership Status§ and Age Group — National Health Interview Survey,¶ United States, 2014



* With 95% confidence intervals indicated with error bars.
† Defined by family respondent's answer to the following question on the family core questionnaire: "Would you say [your] health in general is excellent, very good, good, fair, or poor?"
§ Defined by family respondent's answer to the following question on the family core questionnaire: "Is this house/apartment owned or being bought, rented, or occupied by some other arrangement by [you or someone in your family]?"
¶ Estimates are based on household interviews of a sample of the noninstitutionalized U.S. civilian population and are derived from the National Health Interview Survey family core component.

In 2014, 7% of renters aged 18–39 years assessed their health as fair or poor compared with 4% of homeowners. Among adults aged 40–64 years, 23% of renters reported fair or poor health compared with 11% of homeowners. Among adults aged ≥65 years, 34% of renters reported fair or poor health compared with 19% of homeowners. For both renters or homeowners, the percentage of adults with fair or poor health increased with increasing age.

Source: National Health Interview Survey, 2014 data. http://www.cdc.gov/nchs/nhis.htm.

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