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Inpatient Hospitalization Costs Associated with Birth Defects Among Persons of All Ages — United States, 2013

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In the United States, major structural or genetic birth defects affect approximately 3% of live births (*1*) and are responsible for 20% of infant deaths (*2*). Birth defects can affect persons across their lifespan and are the cause of significant lifelong disabilities. CDC used the Healthcare Cost and Utilization Project (HCUP) 2013 National Inpatient Sample (NIS), a 20% stratified sample of discharges from nonfederal community hospitals, to estimate the annual cost of birth defect–associated hospitalizations in the United States, both for persons of all ages and by age group. Birth defect–associated hospitalizations had disproportionately high costs, accounting for 3.0% of all hospitalizations and 5.2% of total hospital costs. The estimated annual cost of birth defect–associated hospitalizations in the United States in 2013 was $22.9 billion. Estimates of the cost of birth defect–associated hospitalizations offer important information about the impact of birth defects among persons of all ages on the overall health care system and can be used to prioritize prevention, early detection, and care.

CDC used the HCUP 2013 NIS sponsored by the Agency for Healthcare Research and Quality (*3*). The NIS is a 20% stratified sample of discharges from nonfederal community hospitals and does not include rehabilitation and long-term care hospitals. Readmissions for the same person cannot be distinguished, and a person might be included in the data more than once, therefore these data cannot be used to study costs at an individual level. Patients who die during their hospitalization are included in the NIS. CDC included discharges among patients of all ages from January 1 through December 31, 2013. Birth defects were identified through *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes 740.00–759.9. CDC did not consider the following conditions to be birth defects: 1) persistent fetal circulation (747.83) or balanced autosomal translocation in a normal person (758.4), if they were the only codes in this range recorded for the discharge; and 2) patent ductus arteriosus (747.0) or ostium secundum type atrial septal defect (745.5; which includes patent foramen ovale as well as actual atrial septal defects) if they were the only birth defect codes for preterm infants or term infants aged <28 days. For infants aged <1 year, CDC classified acquired pyloric stenosis (537.0) as a birth defect; for persons aged ≥1 year, this was not considered a birth defect. Hospitalizations that included at least one discharge diagnosis with a birth defect ICD-9-CM code meeting these definitions were considered "birth defect–associated" hospitalizations. Eligible birth defect codes found in any diagnosis field (i.e., primary or any of 24 reported

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secondary fields) were analyzed for all birth defects combined, for categories of birth defects broadly defined by organ system (*4*), and for individual defects.

Cost was calculated as the product of facility fee charge, cost-to-charge ratio, and professional fee ratio. The cost-to-charge ratio is used to account for the difference in the amount billed (charge) and the payment received by hospitals (cost). CDC used the HCUP hospital-specific all-payer inpatient cost-to-charge ratio when available, or the weighted group average all-payer inpatient cost-to-charge ratio otherwise (*5*). Hospital charges represent the facility fees charged by hospitals and do not include the cost of physician services, which are billed separately. Professional fee ratios (PFR) provide the means to adjust charges to reflect the estimated cost of services by physicians, which often account for 20%–25% of the cost of a given hospital visit (*6*). CDC obtained PFR data for 2012 Medicaid and commercial insurance and assigned PFRs to discharges by diagnostic-related group (*6*). All discharges of patients aged ≥65 years were assigned commercial PFRs (because Medicare reimburses at a similar rate to commercial insurance), whereas discharges of patients aged <65 years were assigned PFRs based on the coded payer. Data analysis was performed with SAS 9.4 using survey procedures to account for sampling design. The weighted number of discharges with a birth defect diagnosis code were totaled. The mean, median, and total cost were calculated and stratified by organ system and individual defects.

The total weighted cost for birth defect–associated hospitalizations was $22,946,158,457 (Table 1), representing 5.2% of total costs for all hospital discharges. The costs for birth defect–associated hospitalizations were highest among patients aged <1 year ($8,901,015,375) compared with other age groups (Table 1). Among admissions of all patients aged <1 year, birth defect–associated hospitalizations represented 35.0% of total costs. For patients aged 1–5 years, the cost of birth defect–associated hospitalizations was $1,532,487,122, representing 6.7% of total birth defect–associated hospitalization costs. The median cost for birth defect–associated hospitalizations was lowest among patients aged <1 year ($2,126) and highest among patients aged ≥65 years ($13,270) (Table 1).

Among the organ systems considered (Table 2), cardiovascular defects accounted for the largest percentage of birth defect–associated hospitalizations (14.0%), and the highest total cost, approximately $6.1 billion (26.6% of total birth defect–associated hospitalization costs). Within cardiovascular defects, critical congenital heart defect–associated hospitalizations had the highest mean and median cost of the birth defect categories considered ($79,011 and $29,886, respectively). Central nervous system defects accounted for the second most frequent birth defect–associated hospitalizations (6.2%), with a total cost of approximately $1.7 billion. Among non-cardiovascular defects, eye defect–associated hospitalizations had the highest mean cost ($44,441), and ear defects had the highest median cost ($11,349). The specific birth defect with the highest median hospitalization cost was interrupted aortic arch (median = $76,109; interquartile range [IQR] = $14,893–$170,601) (Figure).

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TABLE 1. Weighted estimates for numbers of hospitalizations with at least one birth defect–associated discharge diagnosis,* by age group — National Inpatient Sample, United States, 2013

Age (yrs)	No. (%)†	(95% CI)	Total cost ($) (%)†	(95% CI)	Mean cost ($) (95% CI)	Median cost ($) (IQR)
<1	417,495 (39.3)	(395,092–439,897)	8,901,015,375 (38.8)	(7,671,927,338–10,130,100,000)	21,320 (19,064–23,575)	2,126 (1,108–9,835)
1–5	65,485 (6.2)	(54,843–76,127)	1,532,487,122 (6.7)	(1,192,717,252–1,872,256,992)	23,402 (21,311–25,492)	10,218 (4,958–22,632)
6–18	73,730 (6.9)	(62,783–84,676)	1,980,819,467 (8.6)	(1,579,567,292–2,382,071,642)	26,866 (24,550–29,181)	12,971 (6,235–26,735)
19–64	322,480 (30.4)	(311,315–333,645)	6,640,681,622 (28.9)	(6,281,399,417–6,999,963,827)	20,593 (20,013–21,171)	11,713 (6,251–24,364)
≥65	181,815 (17.1)	(175,683–187,946)	3,891,154,870 (17.0)	(3,711,725,515–4,070,584,226)	21,402 (20,852–21,950)	13,270 (7,437–25,941)
Total	**1,061,004**	**(1,015,274–1,106,733)**	**22,946,158,457**	**(20,894,139,517–24,998,177,397)**	**21,626 (20,415–22,837)**	**8,366 (2,700–20,920)**

Abbreviations: CI = confidence interval; IQR = interquartile range.

* Any primary or secondary (up to 25 total) *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) discharge diagnosis codes 740–759, with the following exceptions: 1) when persistent fetal circulation (747.83) or balanced autosomal translocation in a normal person (758.4) were the only codes in this range recorded for the discharge; or 2) when patent ductus arteriosus (747.0) or ostium secundum type atrial septal defect (745.5, which includes patent foramen ovale as well as actual atrial septal defects) were the only defects coded in a preterm infant or an infant aged <28 days. Infants aged <1 year were classified as having a birth defect if they had acquired pyloric stenosis coded (537.0).

† Because of weighting and rounding, estimates might not sum.

TABLE 2. Weighted estimates for the number, total cost, mean cost, and median cost of birth defect–associated hospitalizations by organ system — National Inpatient Sample, 2013

Birth defect category*	No. (%)	(95% CI)	Total cost ($) (95% CI)	Mean cost ($) (95% CI)	Median cost ($) (IQR)
Central nervous system†	65,509 (6.2)	(59,971–71,048)	1,651,098,167 (1,445,247,680–1,856,948,653)	25,203 (23,727–26,680)	10,559 (5,215-22,859)
CNS: no congenital hydrocephalus§	54,444 (5.1)	(49,823–59,066)	1,280,902,711 (1,111,540,696–1,450,264,725)	23,526 (22,040–25,012)	10,453 (5,209-22,397)
Eye¶	2,174 (0.2)	(1,903–2,446)	96,660,092 (67,765,860–125,554,325)	44,441 (33,364–55,518)	10,341 (3,959-35,908)
Ear**	1,534 (0.1)	(1,249–1,820)	36,116,559 (22,459,211–49,773,908)	23,528 (16,564–30,493)	11,349 (3,118-24,017)
Cardiovascular††	148,184 (14.0)	(137,188–159,180)	6,100,303,945 (5,200,878,936–6,999,728,954)	41,166 (37,630–44,703)	14,552 (6,450-39,316)
CV: critical congenital§§	29,349 (2.8)	(24,583–34,116)	2,318,986,684 (1,774,146,902–2,863,826,466)	79,011 (71,017–87,005)	29,886 (8,367-82,363)
CV: no atrial septal defect¶¶	76,739 (7.2)	(68,370–85,109)	4,138,104,641 (3,351,220,890–4,924,988,393)	53,923 (48,739–59,107)	16,415 (5,105-53,284)
CV: no chromosomal defect***	136,374 (12.9)	(126,819–145,930)	5,467,287,739 (4,689,674,535–6,244,900,944)	40,090 (36,687–43,492)	14,236 (6,404-38,059)
Orofacial†††	18,439 (1.7)	(16,045–20,834)	412,768,370 (336,268,066–489,268,673)	22,384 (19,851–24,917)	9,051 (3,780-17,012)
Gastrointestinal§§§	31,639 (3.0)	(28,416–34,863)	1,118,964,869 (931,459,727–1,306,470,010)	35,365 (32,012–38,718)	9,737 (5,656-23,686)
Genitourinary¶¶¶	46,189 (4.4)	(44,287–48,092)	899,615,075 (808,860,197–990,369,952)	19,476 (17,966–20,986)	7,446 (2,374-17,705)
Musculoskeletal****	27,794 (2.6)	(25,664–29,925)	1,034,300,771 (856,588,012–1,212,013,530)	37,211 (32,841–41,582)	10,370 (2,391-28,792)
Chromosomal††††	48,464 (4.6)	(45,339–51,590)	1,145,462,342 (980,305,170–1,310,619,515)	23,634 (21,292–25,977)	9,067 (4,487-20,743)

Abbreviations: CI = confidence interval; CNS = central nervous system; CV = cardiovascular; IQR = interquartile range.

* Includes primary or any of 24 secondary *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) discharge diagnosis codes.

† Anencephalus (740.0, 740.1), spina bifida without anencephalus (741.00–741.03, 741.90–741.93 without 740.0 or 740.1), congenital hydrocephalus without spina bifida (742.3 without 741.00–741.03, 741.90–741.93), encephalocele (742.0), microcephalus (742.1), or holoprosencephaly (742.2).

§ Same as central nervous system but does not include birth defect–associated hospitalizations where congenital hydrocephalus is the only defect.

¶ Anophthalmia/microphthalmia (743.00, 743.10, 743.11, 743.12), congenital cataract (743.30, 743.31, 743.32, 743.33, 743.34), or aniridia (743.45).

** Anotia/microtia (744.01, 744.23).

†† Common truncus (745.0), transposition of the great arteries (745.10, 745.12, 745.19), tetralogy of Fallot (745.2), ventricular septal defect (745.4), atrial septal defect (745.5 except when it was the only defect coded in a preterm infant or an infant <28 days old), endocardial cushion defect (745.60, 745.61, 745.69), pulmonary valve atresia and stenosis (746.01, 746.02), tricuspid valve atresia and stenosis (746.1), Ebstein anomaly (746.2), aortic valve stenosis (746.3), hypoplastic left heart syndrome (746.7), patent ductus arteriosus (747.0, except when it was the only defect coded in a preterm infant or an infant <28 days old), coarctation of aorta (747.10), double outlet right ventricle (745.11), interrupted aortic arch (747.11), single ventricle (745.3), or total anomalous pulmonary venous connection (747.41).

§§ Common truncus (745.0), transposition of the great arteries (745.10), tetralogy of Fallot (745.2), pulmonary valve atresia (746.01), tricuspid valve atresia and stenosis (746.1), Ebstein anomaly (746.2), hypoplastic left heart syndrome (746.7), coarctation of aorta (747.10), double outlet right ventricle (745.11), interrupted aortic arch (747.11), single ventricle (745.3), or total anomalous pulmonary venous connection (747.41.)

¶¶ Same as cardiovascular but does not include birth defect–associated hospitalizations where atrial septal defect is the only defect.

*** Same as cardiovascular but does not include hospitalizations that include chromosomal abnormalities (trisomy 21 (758.0), trisomy 13 (758.1), trisomy 18 (758.2), Cri-du-chat syndrome (758.31), 22q11 deletion syndrome (758.32), Turner syndrome (758.6), Klinefelter syndrome (758.7), other chromosomal conditions (758.33, 758.39, 758.5, 758.81, 758.89, 758.9).

††† Cleft lip with cleft palate (749.20–749.25), cleft palate without cleft lip (749.00–749.04), cleft lip (749.10–749.14), or choanal atresia (748.0).

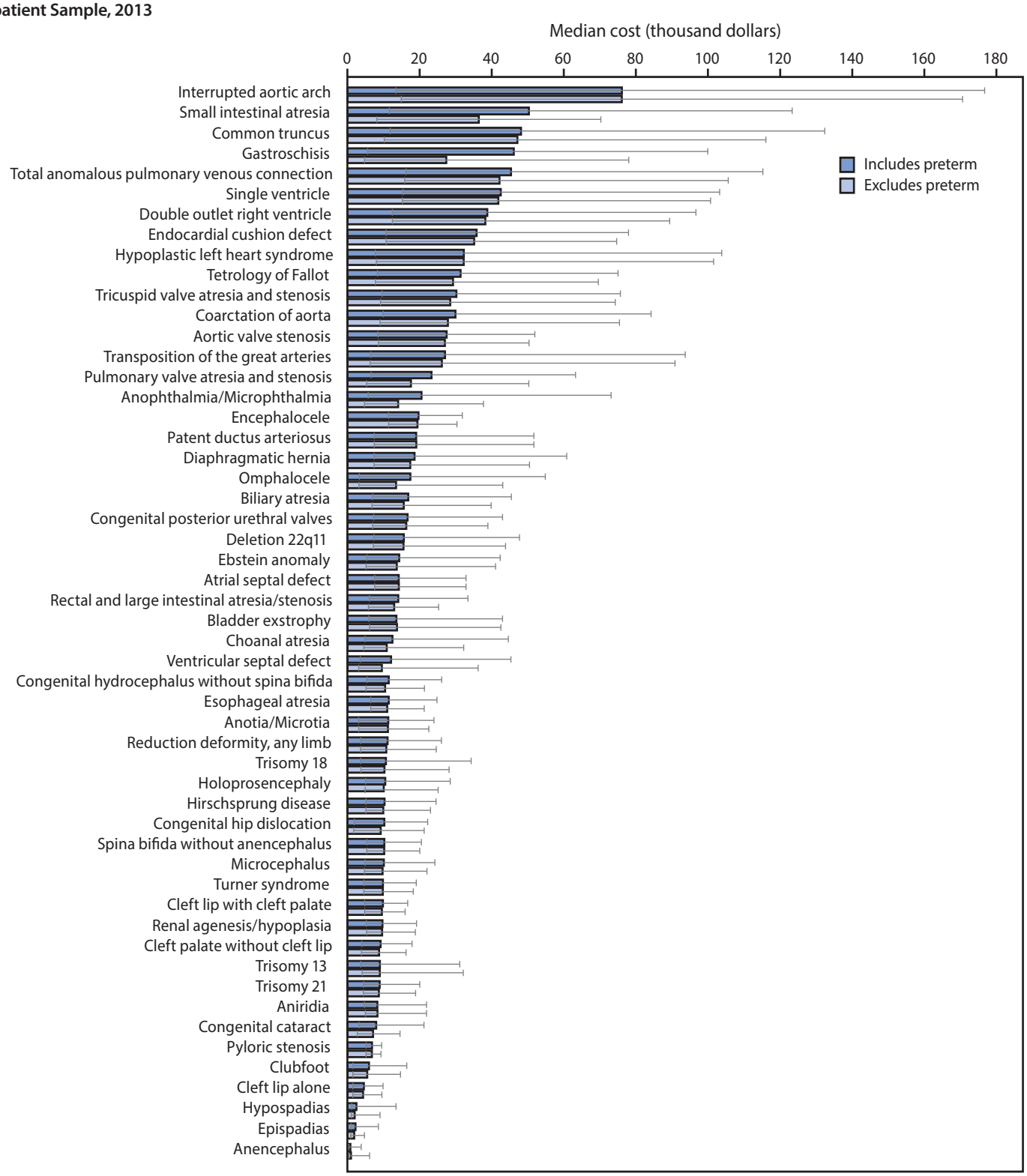
§§§ Esophageal atresia (750.3), rectal and large intestinal atresia/stenosis (751.2), pyloric stenosis (750.5 among all ages; 537.0 among infants aged <1 year), Hirschsprung disease (751.3), biliary atresia (751.61), or small intestinal atresia (751.1).

¶¶¶ Renal agenesis/hypoplasia (753.0), bladder exstrophy (753.5), hypospadias (752.61), epispadias (752.62), congenital posterior urethral valves (753.6).

**** Limb reduction deformity (755.20-755.39), gastroschisis (756.73), omphalocele (756.72), congenital hip dislocation (754.30, 754.31, 754.35), diaphragmatic hernia (756.6), clubfoot (754.51, 754.70).

†††† Trisomy 21 (758.0), trisomy 13 (758.1), trisomy 18 (758.2), 22q11 deletion syndrome (758.32), Turner syndrome (758.6).

FIGURE . Weighted estimated median cost and interquartile range of birth defect–associated hospitalizations, by specific birth defect,*,† — National Inpatient Sample, 2013



See figure footnotes on next page.

FIGURE. (*Continued*) Weighted estimated median cost and interquartile range of birth defect–associated hospitalizations, by specific birth defect,*,† — National Inpatient Sample, 2013

* *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes for each birth defect: anencephalus (740.0, 740.1); spina bifida without anencephalus (741.00, 741.01, 741.02, 741.03, 741.90, 741.91, 741.92, 741.93 without 740.0 or 740.1); congenital hydrocephalus without spina bifida (742.3 without 741.00-741.03, 741.90-741.93); encephalocele (742.0); microcephalus (742.1); holoprosencephaly (742.2); anophthalmia/microphthalmia (743.00, 743.10, 743.11, 743.12); congenital cataract (743.30, 743.31, 743.32, 743.33, 743.34); aniridia (743.45); anotia/microtia (744.01, 744.23); common truncus (745.0); transposition of great arteries (745.10, 745.12, 745.19); tetralogy of Fallot (745.2); ventricular septal defect (745.4); atrial septal defect (745.5, except when it was the only defect coded in a preterm infant or an infant <28 days old); endocardial cushion defect (745.60, 745.61, 745.69); pulmonary valve atresia and stenosis (746.01, 746.02); tricuspid valve atresia and stenosis (746.1); Ebstein anomaly (746.2); aortic valve stenosis (746.3); hypoplastic left heart syndrome (746.7); patent ductus arteriosus (747.0, except when it was the only defect coded in a preterm infant or an infant <28 days old); coarctation of aorta (747.10); double outlet right ventricle (745.11); interrupted aortic arch (747.11); single ventricle (745.3); total anomalous pulmonary venous connection (747.41); cleft palate without cleft lip (749.00, 749.01, 749.02, 749.03, 749.04); cleft lip with cleft palate (749.20, 749.21, 749.22, 749.23,749.24, 749.25); cleft lip alone (749.10, 749.11, 749.12, 749.13, 749.14); choanal atresia (748.0); esophageal atresia/tracheoesophageal fistula (750.3); rectal and large intestinal atresia/stenosis (751.2); pyloric stenosis (750.5 among all ages; 537.0 among infants aged <1 year); Hirschsprung disease (751.3); biliary atresia (751.61); small intestinal atresia/stenosis (751.1); renal agenesis/hypoplasia (753.0); bladder exstrophy (753.5); hypospadias (752.61); epispadias (752.62); congenital posterior urethral valves (753.6); reduction deformity (755.20-755.39); gastroschisis (756.73); omphalocele (756.72); congenital hip dislocation (754.30, 754.31, 754.35); diaphragmatic hernia (756.6); clubfoot (754.51, 754.70); trisomy 13 (758.1); trisomy 21 (758.0); trisomy 18 (758.2); 22q11.2 deletion syndrome (758.32); Turner syndrome (758.6).

† Preterm birth was defined as <37 weeks gestational age (ICD-9-CM codes 765.00–.09, 765.10–.19, 765.21–.28, or Diagnosis Related Group codes 791–792).

Among birth defect–associated hospitalizations, 11.8% had a primary birth defect ICD-9-CM code. The total estimated cost for those hospitalizations was $5,043,781,895 (95% confidence interval [CI] = $4,184,620,375–$5,902,943,416), accounting for 1.1% of total hospital costs and 22.0% of birth defect–associated hospitalization costs when all discharge diagnoses were included. Among the birth defect types examined using only the primary birth defect ICD-9-CM codes, hypoplastic left heart syndrome had the highest mean cost ($164,994; 95% CI = $133,224–$196,763) and interrupted aortic arch had the highest median cost ($119,303; IQR = $68,223–$189,344).

After excluding discharges with ICD-9-CM or Diagnosis Related Group codes indicating preterm birth, the total estimated cost for birth defect–associated hospitalizations was $18,884,865,845 (95% CI = $17,185,471,370–$20,584,260,320) or 82.3% of total costs of all birth defect–associated discharges.

Discussion

CDC's analysis of NIS data indicates that the annual cost of hospitalizations that included a birth defect discharge diagnosis code in 2013 was $22.9 billion. Although birth defect–associated hospitalizations accounted for 3.0% of all hospitalizations, they accounted for 5.2% of total hospital costs, highlighting the disproportionately high costs of treating patients with these conditions. The share of costs was especially high for infants, accounting for 35.0% of total hospitalization costs for children aged <1 year. Across all ages, costs were particularly high for hospitalizations associated with cardiovascular defects, which accounted for approximately 14.0% of birth defect–associated hospitalizations but 26.6% of birth defect–associated costs.

In a previous analysis of 2004 HCUP data, the total cost of birth defect–associated hospitalizations was estimated at $2.6 billion (*7*). This estimate was based only on primary ICD-9-CM discharge diagnosis codes. Inclusion of only primary diagnosis codes in this analysis resulted in an estimate of $5.0 billion. However, estimates based only on the primary ICD-9-CM codes are likely to be an underestimate of costs, because birth is often coded as the principal diagnosis for birth hospitalizations (*8*), and because birth defects might be important factors contributing to hospitalizations associated with other primary diagnosis codes.

The findings in this report are subject to at least five limitations. First, use of all diagnosis codes might have overestimated costs because the coded birth defect might have been incidental to the reason for the hospitalization. Conversely, birth defects that influence conditions leading to hospitalization might be less likely to be coded as a person ages. Second, the primary analysis included preterm infants, who have higher associated hospitalization costs (*9*), potentially leading to an overestimate of cost. Although preterm birth is more common in infants with birth defects (*10*), the extent to which hospitalization costs are attributable to preterm birth, rather than the birth defect, cannot be estimated with these data. Third, some children had more than one birth defect diagnosis; attributing the cost of hospitalization to each defect independently in these children might have resulted in an overestimate of= the cost of one or more of the individual defects. Fourth, although NIS data are routinely used for research, their source data were originally created for billing purposes and diagnoses are not validated, which might have led to an over- or underestimate of average costs. Finally, the cost-to-charge ratios used in this analysis were based on aggregated hospital data and were not specific to the departments or treatments more likely to be used for birth defect hospitalization, which might have affected the cost estimate in either direction.

By estimating the cost of birth defect–associated hospitalizations, both researchers and policy makers can be more informed of the impact of birth defects on the health care system and can use this knowledge to motivate change through prevention, early detection, and care throughout the lifespan of affected persons.

Summary

What is already known about this topic?

Major structural or genetic birth defects affect approximately 3% of live births and are responsible for 20% of infant deaths.

What is added by this report?

Analysis of 2013 hospital discharge data found that birth defect–associated hospitalizations accounted for 3.0% of all hospitalizations and 5.2% of total hospital costs. The estimated annual cost of U.S. hospitalizations that included a birth defect code among any discharge diagnosis was $22.9 billion, whereas the estimated cost based on having a primary birth defect discharge diagnosis code was $5.0 billion. When birth defects among any diagnosis code were included, but preterm delivery codes were excluded, the total estimated cost was $18.9 billion.

What are the implications for public health practice?

Estimates of the cost of birth defect–associated hospitalizations offer important information on the impact of birth defects on the overall health care system and can be used to prioritize prevention measures.

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Association Between The Real Cost Media Campaign and Smoking Initiation Among Youths — United States, 2014–2016

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In the United States, approximately 900,000 youths smoke their first cigarette each year (*1*). Health communication interventions are evidence-based strategies for preventing the initiation of tobacco use, promoting and facilitating cessation, and changing beliefs and attitudes about tobacco use (*2*,*3*). This report describes the association between the Food and Drug Administration's (FDA's) first national tobacco public education campaign, The Real Cost, and rates of smoking initiation among youths in the United States from 2014 to 2016. A nationally representative cohort study of youths (N = 5,185) was conducted during November 2013–March 2016. Results from a discrete-time survival model indicate that, among youths who reported never having smoked a cigarette in the baseline survey, the odds of reporting smoking initiation at follow-up were lower among youths with frequent exposure to campaign advertisements than among those with little or no exposure (adjusted odds ratio [aOR] = 0.70, 95% confidence interval [CI] = 0.55–0.91). Based on the results of the model, The Real Cost is associated with an estimated 348,398 U.S. youths aged 11–18 years who did not initiate smoking during February 2014–March 2016. Sustained youth-focused tobacco education campaigns, such as The Real Cost, can help speed progress toward preventing tobacco use among youths in the United States.

FDA's The Real Cost was based on behavior change theories and designed to prevent the initiation of cigarette smoking among youths who have never smoked and discourage further smoking among youths who have previously experimented with smoking (*4*) (RTI International and FDA, unpublished data, 2016). Since February 2014, the campaign has aired tobacco education advertising designed for youths aged 12–17 years on national television, radio, the Internet, and in out-of-home displays, as well as in magazines and movie theaters (*4*). The central theme of the campaign is "Every cigarette costs you something." In the first 3 years of advertising, campaign themes focused on the cosmetic effects of smoking, loss of control caused by addiction, and the dangerous mix of toxic chemicals in cigarette smoke.* To monitor campaign awareness levels (*4*) and evaluate the impact of The Real Cost on changes in smoking-related beliefs (RTI International and FDA, unpublished data, 2016) and behaviors, FDA conducted a national representative cohort study of U.S. youths. Youths aged 11–16 years at baseline were randomly selected from within 75 U.S. media markets and, after obtaining parental permission and youth assent, were interviewed in person at baseline during November 2013–March 2014. Data collections for the three follow-up surveys were conducted during July–October 2014, April–July 2015, and December 2015–March 2016 and consisted of online or in-person interviews.† This report used data from the baseline survey and the first three follow-up surveys to determine whether campaign exposure was associated with preventing smoking initiation among youths who had never smoked at baseline (never smokers). The analytic sample consisted of 5,185 eligible youths, and the model included 11,145 observations across the surveys.§

Self-reported campaign media exposure was assessed with a validated measure (*5*) at each follow-up survey via video stream embedded within the survey. After viewing each advertisement, respondents reported their frequency of exposure to the advertisement on a scale from 0 (never) to 4 (very often). Respondents viewed all advertisements airing during the 3 months preceding each follow-up survey (a total of four advertisements at first and second follow-ups, and six advertisements at third follow-up). The frequency of exposure to all ads in each survey were summed, resulting in a score ranging from 0 to 16 at first and second follow-ups and from 0 to 24 at third follow-up. A dichotomous exposure measure was then created, defined as either low campaign exposure (<4) or high campaign exposure (≥4). Smoking initiation was defined as first trial of a cigarette among youths who had never used cigarettes.¶

* http://www.fda.gov/TobaccoProducts/PublicHealthEducation/PublicEducationCampaigns/TheRealCostCampaign/.

† All youths aged 11–16 years in selected households were eligible for the baseline survey. Youths were selected within 75 Nielsen Designated Market Areas using 2010 Census Bureau block groups as the secondary sampling unit. At baseline, the unweighted household-level response rate was 48%, and follow-up response rates ranged from 87% to 91% (American Association of Public Opinion Research Response Rate #3 formula).

§ The analytic sample included youths who reported they had never smoked (never smokers) at baseline and completed at least one follow-up survey (91% of respondents were never smokers at baseline and of these, 87% responded to at least one follow-up survey).

¶ "Never use" of cigarettes was examined using the measure: "Have you ever tried cigarette smoking, even one or two puffs?" including response options of "Yes," "No," and "Don't Know." Youths who had never used cigarettes were coded as respondents who said "No."

A discrete-time survival model (*6*,*7*) was estimated using logistic regression and controlling for confounding influences, similar to other longitudinal media studies (*8*).** Because the delivery of advertisements is not explicitly random, the model included four types of potential confounders: demographic characteristics, individual risk factors for smoking cigarettes, self-reported exposure to other national campaigns (CDC's Tips From Former Smokers and Truth Initiative's truth campaign), and media market and state-level variables. The estimated number of youths prevented from initiating smoking was calculated using the difference between the predicted risk for initiation by age with actual exposure to The Real Cost campaign and the predicted risk for initiation by age in a hypothetical scenario where self-reported exposure to the campaign is either absent or low nationwide. The difference in initiation rates was then applied to the national population of nonsmoking youths at each age (2010 Census), and the resulting estimated numbers of youths potentially prevented from initiating smoking at each age were summed. Sensitivity analyses were conducted to examine the influence of electronic cigarettes (e-cigarettes) and other tobacco products on smoking initiation. An additional model examined the relationship between campaign exposure and using marijuana, a risky behavior unrelated to campaign messaging. This additional analysis was conducted to ascertain whether campaign effects were specific to smoking behaviors and not a general association between campaign exposure and risky behaviors.

High campaign exposure was associated with a 30% decrease in the risk for smoking initiation (aOR = 0.70, 95% CI = 0.55–0.91) (Table). The decrease in the risk for smoking initiation is illustrated by the difference between the risk for initiation with actual exposure to The Real Cost and the risk for initiation in a hypothetical scenario where there is no or low self-reported exposure to The Real Cost nationwide (Figure 1). Based on the results of the survival model, an estimated 348,498 youths aged 11–18 years were potentially prevented from initiating smoking nationwide during February 2014–March 2016 (95% CI = 331,825–365,168) (Figure 2).

The association between campaign exposure and youth smoking initiation remained unchanged in survival models that accounted for youths' use of e-cigarettes and other tobacco products during the study period. In a similar survival model, exposure to The Real Cost was not associated with a change in the likelihood of marijuana initiation.

** This analytic approach begins with all youths who never smoked and then estimates the risk for smoking initiation as they age. Once the event of interest (initiation of smoking) occurs, the youth is dropped from subsequent time periods, thus allowing calculation of the probability that a youth will initiate smoking at each age, given that the youth had not previously begun smoking.

TABLE. Results of a discrete-time survival model of the relationship between self-reported exposure to The Real Cost media campaign and smoking initiation by youths aged 11–18 years — United States, 2014–2016

Explanatory variable*	OR (95% CI)
High exposure to The Real Cost (referent = no or low exposure)	0.70† (0.55–0.91)
Gender (referent = female)	
Male	1.03 (0.86–1.24)
Race/Ethnicity (referent = white, non-Hispanic)	
Black, non-Hispanic	1.35 (0.99–1.84)
Hispanic	1.39† (1.11–1.73)
Other, non-Hispanic	0.77 (0.54–1.09)
Youth income§	1.03 (0.99–1.07)
Lives with tobacco user¶	2.44** (2.04–2.92)
Sensation seeking scale††	1.40** (1.25–1.56)
School environment§§	0.85† (0.77–0.94)
School performance¶¶	0.78** (0.70–0.87)
Educational plans***	0.92††† (0.84–1.00)
Parental communication§§§	0.84** (0.76–0.94)
Television use¶¶¶	1.03† (1.01–1.06)

Abbreviations: CI = confidence interval; OR = odds ratio.

* Additional control variables include average market-level family income, average market-level high school completion rates, market population, 2013 Behavioral Risk Factor Surveillance System state smoking prevalence, measures of self-reported exposure to the Tips From Former Smokers and the Truth Initiative's truth campaigns, an indicator for whether the youth's baseline interview was conducted after the launch of The Real Cost, age indicators, and time trend indicators.

† p<0.01.

§ The amount of weekly discretionary income.

¶ Lives with a person who uses tobacco, including cigarettes, cigars, hookah, smokeless, and other tobacco products.

** p<0.001.

†† The brief sensation seeking scale (BSSS-4) is a mean of four items: 1) "I would like to explore strange places"; 2) "I like to do frightening things"; 3) "I like new and exciting experiences, even if I have to break the rules"; and 4) "I prefer friends who are exciting and unpredictable." Responses ranged from 1 (disagree strongly) to 5 (agree strongly).

§§ School environment was measured as the mean of three items: 1) "I feel close to people at my school"; 2) "I am happy to be at my school"; and 3) "I feel like I am a part of my school." Responses ranged from 1 (disagree strongly) to 5 (agree strongly).

¶¶ School performance was assessed with the item "How well would you say you have done in school?" with response options from 1 (much worse than average) to 5 (much better than average).

*** School aspirations were assessed with the item "How far do you think you will go in school?" with response options from 1 (I don't plan to go to school anymore) to 8 (graduate, medical, or law school).

††† p<0.05.

§§§ A youth's relationship with parents was a mean of two items: 1) "Thinking about the adult or adults you live with would you say you are satisfied with the way you communicate with each other" (responses from 1 [very unsatisfied] to 5 [very satisfied]), and 2) "How close do you feel to the adult or adults you live with?" (Responses ranged from 1 [not close at all] to 5 [very close]).

¶¶¶ Continuous variable of daily hours spent watching television across all media devices.

Discussion

The findings from this analysis indicate that exposure to The Real Cost campaign was associated with preventing an estimated 348,398 U.S. youths aged 11–18 years from initiating smoking during 2014–2016. Most tobacco dependence begins during adolescence (*3*), and youth-focused campaigns to prevent smoking

FIGURE 1. Estimated smoking initiation risk among youths aged 11–18 years with actual exposure versus hypothetical scenario with low or no exposure to The Real Cost campaign, by age — United States, 2014–2016

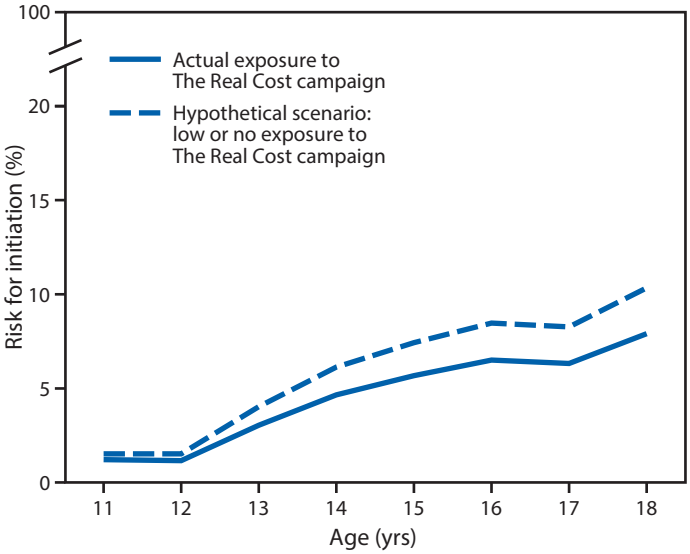
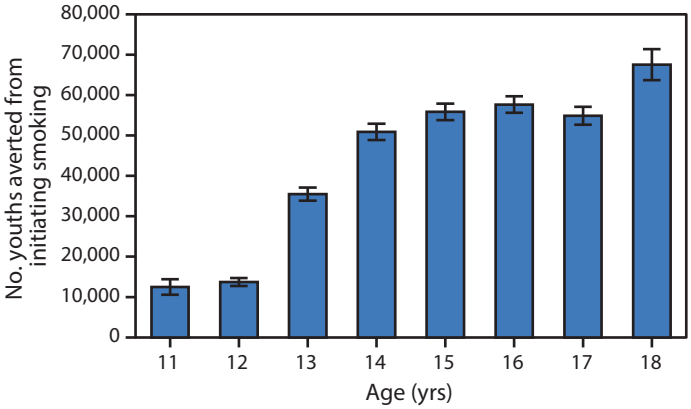


FIGURE 2. Predicted number of youths* aged 11–18 years potentially prevented from initiating smoking as a result of The Real Cost campaign, by age — United States, 2014–2016



* With 95% confidence intervals represented by error bars.

initiation, such as The Real Cost, can have long-term effects on future rates of tobacco-related morbidity and mortality (*9*).

Findings from this report support previous studies that indicate The Real Cost meets or exceeds guidelines for effective health communication interventions (*2*). FDA conducted formative research to develop campaign advertisements for The Real Cost, including qualitative and quantitative testing of campaign messages and draft advertisements (RTI International and FDA, unpublished data, 2016). Since its launch, campaign advertising has occurred with high frequency across multiple media channels targeting youths. Research indicates that approximately 9 of 10 youths reported seeing The Real Cost advertisements after 7 months, with more youths reporting awareness of advertising

Summary

What is already known about this topic?

Public education campaigns are evidence-based strategies for positive public health outcomes such as preventing the initiation of tobacco use, promoting and facilitating cessation, and shaping social norms related to tobacco use.

What is added by this report?

This study is the first to examine the association between the Food and Drug Administration's (FDA's) youth-specific national media campaign, The Real Cost, and adolescent smoking in the United States. Approximately 350,000 youths aged 11–18 years were prevented from smoking nationwide during 2014–2016 as a result of FDA's youth-specific public education campaign.

What are the implications for public health practice?

The findings indicate that youths' self-reported exposure to the campaign was associated with a reduction in smoking initiation from 2014 to 2016. Sustained campaigns such as The Real Cost can speed progress toward a tobacco-free future.

in subsequent surveys (*4*). The Real Cost was also found to positively influence tobacco-related risk perceptions and beliefs specific to campaign messages after 15 months (RTI International and FDA, unpublished data, 2016). These results demonstrate the effectiveness of a national campaign that focused on the harmful effects of smoking and delivered salient messages that resonated with youths.

These findings align with previous research that found targeted mass media campaigns, delivered with sufficient intensity and duration, can decrease smoking initiation and prevalence (*2*,*9*). A comprehensive tobacco control approach that emphasizes proven strategies, such as The Real Cost, can result in reductions in smoking among youths today, and such reductions can lead to decreased future rates of smoking-attributable mortality, health care costs, and lost workplace productivity (*3*,*9*).

The findings in this report are subject to at least four limitations. First, measurements were self-reported and are subject to bias. Specifically, selective attention could bias the results, such that nonsmoking youths at risk for future smoking might be more likely to both pay attention to campaign messages and experiment with smoking. However, such a positive association would be expected to lead to smaller observed campaign effects on initiation. In addition, social desirability bias might have led to underreporting of initiation and overreporting of campaign exposure. To address the concerns of using self-reported exposure, future research that examines potential campaign exposure based on measures of market-level media delivery (i.e., target rating points[††]) is warranted.

[††]Nielsen's system of target rating points are the standard unit of measurement for media delivery and measure the reach and frequency of an advertisement among a target population.

Second, although the model controls for youths' exposure to other tobacco-related media campaigns, this might not fully account for the independent or synergistic effects of the other campaigns. Third, sample attrition might result in bias. However, attrition analyses indicate the baseline and follow-up samples were similar across demographics, susceptibility to smoking cigarettes, and household tobacco use. Finally, because of sample size limitations, only initiation to smoking was examined, not progression to established or daily smoking. Future analyses could examine the campaign's effect on youth smoking prevalence and further explore the campaign's effect among demographic subgroups.

The Real Cost is the first federally funded U.S. youth-focused tobacco education campaign, and these findings indicate that youths' self-reported exposure to the campaign was associated with a reduction in smoking initiation during the evaluation's 2014 to 2016 time frame. Sustained tobacco education campaigns such as The Real Cost can encourage U.S. youths to abstain from tobacco use and accelerate progress toward future tobacco-free generations.

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West Nile Virus and Other Nationally Notifiable Arboviral Diseases — United States, 2015

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Arthropod-borne viruses (arboviruses) are transmitted to humans primarily through the bites of infected mosquitoes and ticks. The leading cause of domestically acquired arboviral disease in the United States is West Nile virus (WNV) (*1*). Other arboviruses, including La Crosse, St. Louis encephalitis, Jamestown Canyon, Powassan, and eastern equine encephalitis viruses, also cause sporadic cases and outbreaks. This report summarizes surveillance data reported to CDC in 2015 for nationally notifiable arboviruses. It excludes dengue, chikungunya, and Zika viruses, which are primarily nondomestic viruses typically acquired through travel (and are addressed in other CDC reports). In 2015, 45 states and the District of Columbia (DC) reported 2,282 cases of domestic arboviral disease. Among these cases, 2,175 (95%) were WNV disease and 1,455 (67%) of those were classified as neuroinvasive disease (meningitis, encephalitis, or acute flaccid paralysis). The national incidence of WNV neuroinvasive disease was 0.45 cases per 100,000 population. Because arboviral diseases continue to cause serious illness, maintaining surveillance is important to direct prevention activities such as reduction of vector populations and screening of blood donors.

Arboviruses are maintained in a transmission cycle between arthropods and vertebrate hosts. Humans primarily become infected when bitten by an infected tick or mosquito. Person-to-person transmission of domestic arboviruses has been reported through blood transfusion and organ transplantation (*3*). Most human infections are asymptomatic; symptomatic infections commonly manifest as a systemic febrile illness, and, less commonly, as neuroinvasive disease.

Most endemic arboviral diseases are nationally notifiable and are reported to CDC through ArboNET, a national arboviral surveillance system managed by CDC and state health departments (*2*,*3*). Using standard definitions, human cases with laboratory evidence of recent arboviral infection are classified as neuroinvasive or nonneuroinvasive disease (*2*). Cases reported as encephalitis, meningitis, or acute flaccid paralysis are collectively referred to as neuroinvasive disease; others are considered nonneuroinvasive disease. Acute flaccid paralysis can occur with or without encephalitis or meningitis. In this report, any case reported as acute flaccid paralysis (with or without another clinical syndrome) was classified as acute flaccid paralysis and not included in the other categories. Because ArboNET is a passive surveillance system, detection and reporting of neuroinvasive disease is thought to be more consistent and more complete than nonneuroinvasive disease. For this reason, incidence rates were calculated using neuroinvasive disease cases and U.S. Census 2015 mid-year population estimates.

During 2015, a total of 2,282 cases of domestic arboviral disease were reported to CDC. Cases were caused by WNV (2,175 cases, 95%), La Crosse virus (55), St. Louis encephalitis (23), Jamestown Canyon virus (11), Powassan virus (seven), eastern equine encephalitis virus (six), unspecific California serogroup virus (four), and Cache Valley virus (one). Of the 3,141 U.S. counties, 611 (19%) reported one or more cases of arboviral disease. No cases of domestic arboviral disease were reported from Alaska, Hawaii, New Hampshire, Rhode Island, or Vermont.

The 2,175 WNV disease cases were reported from 506 counties in 43 states and DC, including 1,455 (67%) that were neuroinvasive, and 1,804 (83%) with illness onset during July–September (Table 1). The median age of patients was 58 years (interquartile range [IQR] = 46–69 years), and 1,289 (59%) patients were male. A total of 1,616 (74%) patients with WNV disease were hospitalized, and 146 (7%) died. The median age of patients who were hospitalized was 61 years (IQR = 50–73 years), and 996 (62%) were male. The median age of patients who died was 76 years (IQR = 66–83 years), and 94 (64%) were male.

Among the 1,455 WNV neuroinvasive disease cases, 686 (47%) were reported as encephalitis, 613 (42%) as meningitis, 118 (8%) as acute flaccid paralysis, and 20 (1%) as other neurologic signs or symptoms. Among the 118 patients with reported acute flaccid paralysis, 91 (77%) also had encephalitis or meningitis. Among patients with neuroinvasive disease, 1,382 (95%) were hospitalized, and 142 (10%) died. The incidence of neuroinvasive WNV disease in the United States was 0.45 per 100,000 population (Table 2). The states with the highest incidence rates included California (1.49 per 100,000), North Dakota (1.32), South Dakota (1.28), and Oklahoma (1.25) (Table 2) (Figure). Sixty-one percent of all neuroinvasive disease cases were reported from California (585 cases) and Texas (196). The incidence of WNV neuroinvasive disease increased with age, from 0.04 per 100,000 children aged <18 years to 1.36 in adults aged ≥70 years. The incidence was higher among males (0.57 per 100,000) than among females (0.34).

Fifty-five La Crosse virus disease cases were reported from 10 states. Of these, 51 (93%) were neuroinvasive (Table 1).

TABLE 1. Number and percentage of reported cases of West Nile virus and other arboviral diseases, by virus type and selected patient characteristics — United States, 2015*

Characteristic	Virus type					
	West Nile (N = 2,175) No. (%)	La Crosse (N = 55) No. (%)	St. Louis encephalitis (N = 23) No. (%)	Jamestown Canyon (N = 11) No. (%)	Powassan (N = 7) No. (%)	Eastern equine encephalitis (N = 6) No. (%)
Age group (yrs)						
<18	54 (2)	51 (93)	0 (0)	1 (9)	0 (0)	1 (17)
18–59	1,108 (51)	1 (2)	9 (39)	6 (55)	1 (14)	2 (33)
≥60	1,013 (47)	3 (5)	14 (61)	4 (36)	6 (86)	3 (50)
Sex						
Male	1,289 (59)	31 (56)	15 (65)	6 (55)	5 (71)	6 (100)
Female	886 (41)	24 (44)	8 (35)	5 (45)	2 (29)	0 (0)
Period of illness onset						
January–March	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
April–June	60 (3)	7 (13)	3 (13)	5 (45)	4 (57)	1 (17)
July–September	1,804 (83)	47 (85)	19 (83)	5 (45)	1 (14)	5 (83)
October–December	309 (14)	1 (2)	1 (4)	1 (9)	2 (29)	0 (0)
Clinical syndrome						
Nonneuroinvasive	720 (33)	4 (7)	4 (17)	5 (45)	1 (14)	0 (0)
Neuroinvasive	1,455 (67)	51 (93)	19 (83)	6 (55)	6 (86)	6 (100)
Encephalitis	753 (35)	40 (73)	12 (52)	4 (36)	6 (86)	2 (33)
Meningitis	637 (29)	10 (18)	7 (30)	1 (9)	0 (0)	2 (33)
Acute flaccid paralysis†	118 (5)	2 (4)	1 (4)	1 (9)	0 (0)	0 (0)
Other	20 (1)	0 (0)	1 (4)	1 (9)	1 (14)	0 (0)
Outcome						
Hospitalization	1,616 (74)	52 (95)	19 (83)	9 (82)	7 (100)	6 (100)
Death	146 (7)	0 (0)	2 (9)	0 (0)	1 (14)	4 (67)

* Four unspecified California serogroup virus cases and one Cache Valley virus case also were reported.
† Of the 118 West Nile virus disease patients with acute flaccid paralysis, 91 (77%) also had encephalitis or meningitis.

Illness onset ranged from March to December, with 47 (85%) cases having onset during July–September. Thirty-one (56%) patients were male. The median age was 8 years (IQR = 5–80 years), and 51 (93%) were aged <18 years. Fifty-two (95%) patients were hospitalized; none died. Of those hospitalized, 50 (96%) were neuroinvasive disease cases. Incidence of La Crosse virus neuroinvasive disease was highest in Ohio (0.20 per 100,000), West Virginia (0.16), and North Carolina (0.11) (Table 2).

Twenty-three cases of St. Louis encephalitis virus disease were reported, all from Arizona. The median age of patients was 65 years (IQR = 51–73), and 15 (65%) were male. Illness onset date ranged from March to December, with 19 (83%) patients having onset during July–September. Nineteen (83%) cases were neuroinvasive (Table 1). All neuroinvasive disease patients were hospitalized, and none of the nonneuroinvasive disease patients were hospitalized. There were two deaths, in patients aged 67 and 73 years.

Eleven Jamestown Canyon virus disease cases were reported from seven states (Iowa, Massachusetts, Minnesota, New Jersey, Ohio, Wisconsin, and Wyoming). Illness onset ranged from March to December; five cases had onset during April–June and five during July–September. The median age was 56 years (IQR = 41–62 years). Six cases were neuroinvasive, nine patients were hospitalized, and none died.

Seven Powassan virus disease cases were reported from five states (Maine, Massachusetts, New Jersey, New York, and Wisconsin). The median age of patients was 64 years (IQR = 62–75 years), and five patients were male. Six cases were neuroinvasive. All patients were hospitalized, and one died. Illness onset ranged from March to December.

Six cases of eastern equine encephalitis virus disease were reported from four states (Louisiana, Maine, New York, and North Carolina); all were neuroinvasive disease. The median age of patients was 59 years (IQR = 50–78 years), and all patients were male. Illness onset ranged from March to September. All patients were hospitalized, and four died.

In addition to the La Crosse and Jamestown Canyon virus cases, there were four other cases of California serogroup virus disease for which the specific infecting virus was unknown. One case of Cache Valley virus disease was reported from Missouri.

Discussion

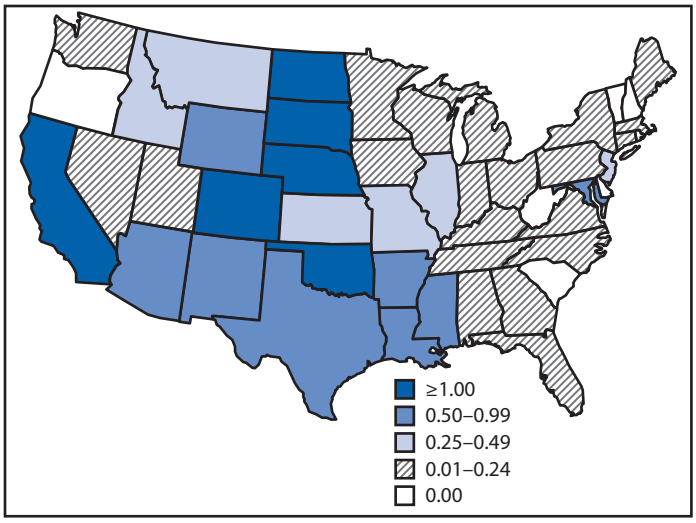
In 2015, WNV remained the most common cause of neuroinvasive arboviral disease in the continental United States and was responsible for 94% of the reported neuroinvasive disease cases. The WNV neuroinvasive disease incidence in 2015 was similar to the median incidence during 2002–2014 (0.41 per 100,000 population; range = 0.13–1.02) (*3*,*4*). Although the

TABLE 2. Number and rate* of reported cases of arboviral neuroinvasive disease, by virus type, U.S. Census division, and state — United States, 2015

U.S. Census division/State	Virus type					
	West Nile No. (Rate)	La Crosse No. (Rate)	St. Louis encephalitis No. (Rate)	Jamestown Canyon No. (Rate)	Powassan No. (Rate)	Eastern equine encephalitis No. (Rate)
United States	**1,455 (0.45)**	**51 (0.02)**	**19 (0.01)**	**6 (<0.01)**	**6 (<0.01)**	**6 (<0.01)**
New England	**16 (0.11)**	**—**	**—**	**1 (0.01)**	**4 (0.03)**	**1 (0.01)**
Connecticut	8 (0.22)	—	—	—	—	—
Maine	1 (0.08)	—	—	—	1 (0.08)	1 (0.08)
Massachusetts	7 (0.1)	—	—	1 (0.01)	3 (0.04)	—
New Hampshire	—	—	—	—	—	—
Rhode Island	—	—	—	—	—	—
Mid Atlantic	**82 (0.2)**	**—**	**—**	**1 (<0.01)**	**1 (<0.01)**	**3 (0.01)**
Vermont	—	—	—	—	—	—
New Jersey	23 (0.26)	—	—	1 (0.01)	1 (0.01)	—
New York	42 (0.21)	—	—	—	—	3 (0.02)
Pennsylvania	17 (0.13)	—	—	—	—	—
E. North Central	**112 (0.24)**	**29 (0.06)**	**—**	**3 (0.01)**	**1 (<0.01)**	**—**
Illinois	51 (0.4)	—	—	—	—	—
Indiana	16 (0.24)	—	—	—	—	—
Michigan	16 (0.16)	—	—	—	—	—
Ohio	23 (0.2)	23 (0.2)	—	1 (0.01)	—	—
Wisconsin	6 (0.1)	6 (0.1)	—	2 (0.03)	1 (0.02)	—
W. North Central	**82 (0.39)**	**1 (<0.01)**	**—**	**1 (<0.01)**	**—**	**—**
Iowa	4 (0.13)	—	—	—	—	—
Kansas	12 (0.41)	1 (0.03)	—	—	—	—
Minnesota	3 (0.05)	—	—	1 (0.02)	—	—
Missouri	23 (0.38)	—	—	—	—	—
Nebraska	19 (1.0)	—	—	—	—	—
North Dakota	10 (1.32)	—	—	—	—	—
South Dakota	11 (1.28)	—	—	—	—	—
S. Atlantic	**76 (0.12)**	**17 (0.03)**	**—**	**—**	**—**	**1 (<0.01)**
Delaware	—	—	—	—	—	—
District of Columbia	3 (0.45)	—	—	—	—	—
Florida	12 (0.06)	—	—	—	—	—
Georgia	13 (0.13)	2 (0.02)	—	—	—	—
Maryland	31 (0.52)	—	—	—	—	—
North Carolina	4 (0.04)	11 (0.11)	—	—	—	1 (0.01)
South Carolina	—	1 (0.02)	—	—	—	—
Virginia	13 (0.16)	—	—	—	—	—
West Virginia	—	3 (0.16)	—	—	—	—
E South Central	**36 (0.19)**	**3 (0.02)**	**—**	**—**	**—**	**—**
Alabama	5 (0.1)	—	—	—	—	—
Kentucky	1 (0.02)	—	—	—	—	—
Mississippi	25 (0.84)	—	—	—	—	—
Tennessee	5 (0.08)	3 (0.05)	—	—	—	—
W South Central	302 (0.77)	1 (<0.01)	—	—	—	1 (<0.01)
Arkansas	16 (0.54)	—	—	—	—	—
Louisiana	41 (0.88)	1 (0.02)	—	—	—	1 (0.02)
Oklahoma	49 (1.25)	—	—	—	—	—
Texas	196 (0.71)	—	—	—	—	—
Mountain	**156 (0.66)**	**—**	**19 (0.08)**	**—**	**—**	**—**
Arizona	67 (0.98)	—	19 (0.28)	—	—	—
Colorado	57 (1.04)	—	—	—	—	—
Idaho	5 (0.3)	—	—	—	—	—
Montana	3 (0.29)	—	—	—	—	—
Nevada	4 (0.14)	—	—	—	—	—
New Mexico	12 (0.58)	—	—	—	—	—
Utah	5 (0.17)	—	—	—	—	—
Wyoming	3 (0.51)	—	—	—	—	—
Pacific	**593 (1.13)**	**—**	**—**	**—**	**—**	**—**
Alaska	—	—	—	—	—	—
California	585 (1.49)	—	—	—	—	—
Hawaii	—	—	—	—	—	—
Oregon	—	—	—	—	—	—
Washington	8 (0.11)	—	—	—	—	—

* Per 100,000 population, based on July 1, 2015, U.S. Census population estimates.

FIGURE. Rate* of reported cases of West Nile virus neuroinvasive disease — United States, 2015



* Per 100,000 population.

Summary

What is already known about this topic?

Arboviral disease can cause substantial morbidity and mortality in the United States. West Nile virus (WNV) is the leading cause of domestically acquired arboviral disease, but several other arboviruses cause sporadic cases and outbreaks of neuroinvasive disease.

What is added by this report?

In 2015, WNV remained the most common cause of neuroinvasive arboviral disease in the United States, with a similar incidence to the median incidence during 2002–2014. In addition, Arizona experienced an outbreak of St. Louis encephalitis virus, and four new states reported their first Jamestown Canyon virus disease cases in 2015.

What are the implications for public health practice?

Arboviral diseases are a continuing source of severe illness in the United States each year. Surveillance remains important to identify outbreaks and guide prevention strategies.

overall case fatality rate for WNV was slightly elevated in 2015 (7%) compared with rates reported previously (median = 5%; range = 3%–15%), the proportion of total cases reported that were neuroinvasive disease also increased, which could account for the higher case fatality rate (*4*). As previously reported, La Crosse virus was the most common cause of neuroinvasive arboviral disease among children (*5*). Four states (Iowa, New Jersey, Ohio, and Wyoming) reported Jamestown Canyon virus for the first time. This likely represents better detection following the routine implementation of Jamestown Canyon virus immunoglobulin M antibody testing at CDC (*6*). All cases of St. Louis encephalitis were reported from Arizona, which experienced a concurrent outbreak of WNV and St. Louis encephalitis virus disease (*7*). Eastern equine encephalitis virus, although rare, remained the most severe domestic arboviral disease, with four deaths reported among six patients.

Arboviruses continue to cause substantial morbidity in the United States, although the reported number of cases varies annually. Cases occur sporadically, and the epidemiology varies by virus and geographic area. Approximately 85% of arboviral disease cases occurred during April–September. Weather, zoonotic host and vector abundance, and human behavior are all factors that can influence when and where outbreaks occur. These factors make it difficult to predict future locations and timing of cases and highlight the importance of surveillance to identify outbreaks and inform public health prevention.

The findings in this report are subject to at least two limitations. First, ArboNET is a passive surveillance system, which leads to an underestimation of the true incidence of disease. To be reported as a disease case, persons must seek care, a clinician must request appropriate diagnostic tests, and health care providers and laboratories need to report cases to public health authorities. Previous studies have estimated that there are 30–70 nonneuroinvasive disease cases for every reported case of WNV neuroinvasive disease (*8*–*10*). Based on the number of neuroinvasive disease cases reported in 2015, it was expected that 43,650–101,850 nonneuroinvasive disease cases would have occurred; however, only 720 (0.1–1%) were reported. Second, because ArboNET does not require information about clinical signs and symptoms or laboratory findings, cases might be misclassified.

Health care providers should consider arboviral infections in the differential diagnosis of cases of aseptic meningitis and encephalitis, obtain appropriate specimens for laboratory testing, and promptly report cases to public health authorities (*2*). Because human vaccines against domestic arboviruses are not available, prevention depends on community and household efforts to reduce vector populations (e.g., applying insecticides and reducing breeding sites), personal protective measures to decrease exposure to mosquitoes and ticks (e.g., use of repellents and wearing protective clothing), and screening of blood donors.

Acknowledgments

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Coverage with Tetanus, Diphtheria, and Acellular Pertussis Vaccine and Influenza Vaccine Among Pregnant Women — Minnesota, March 2013–December 2014

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Pertussis and influenza infections can result in severe disease in infants. The diphtheria, tetanus, acellular pertussis (DTaP) vaccine is recommended for infants beginning at age 2 months, and influenza vaccine is recommended for infants aged ≥6 months. Vaccination of pregnant women induces the production of antibodies that are transferred across the placenta to the fetus and provide passive protection until infants are old enough to receive DTaP and influenza vaccines (*1*–*3*). To protect young infants before they are age-eligible for vaccination, the Advisory Committee on Immunization Practices (ACIP) has recommended since 2004 that all women who are or will be pregnant during influenza season receive inactivated influenza vaccine (*1*), and since 2013 that all pregnant women receive the tetanus, diphtheria, acellular pertussis (Tdap) vaccine (*3*). Tdap and influenza vaccination coverage was assessed among pregnant women in Minnesota. Vital records data containing maternal demographic characteristics, prenatal care data, and delivery payment methods were matched with vaccination data from the Minnesota Immunization Information Connection (MIIC) to assess vaccination coverage. MIIC stores vaccination records for Minnesota residents. Overall, coverage with Tdap vaccine was 58.2% and with influenza vaccine was 45.9%. Coverage was higher for each vaccine among women who received adequate prenatal care compared with those who received inadequate or intermediate care, based on the initiation of prenatal care and the number of recommended prenatal visits attended. Coverage also varied based on mother's race, country of birth or region, and other demographic characteristics. Further study is needed to better understand the maternal vaccination disparities found in this study and to inform future public health initiatives.

Tdap and influenza vaccination coverage was assessed among women in Minnesota who had delivered a live birth during March 2, 2013–December 31, 2014. The beginning date was selected because it occurred 1 week after the most recent change in Tdap recommendations for pregnant women, providing an opportunity for most women included in the assessment to be vaccinated before delivery. Records for every live birth in Minnesota during March 2, 2013–December 31, 2014 were obtained from the Minnesota Department of Health's Office of Vital Records. Demographic characteristics, including mother's race, ethnicity, birth country, participation in the Special Supplemental Nutrition Program for Women Infants and Children (WIC) program, marital status, education level, gestational duration, prenatal care adequacy (assessed using the Kotelchuck Index*), and delivery payment methods were abstracted from the birth record. The Kotelchuck Index score was computed using vital records information on when prenatal care began and how many prenatal care visits were attended (*4*). Assessment was performed on the rate of receipt of ≥1 doses of Tdap vaccine and ≥1 doses of influenza vaccine during pregnancy among women in this cohort.

Using vital records data, a list of Minnesota women who delivered a live birth during March 2, 2013–December 31, 2014 was compiled and pregnancy intervals were calculated. This list was matched by mother's name and birthdate to MIIC records. Tdap and influenza vaccinations during pregnancy were assessed. Frequencies, percentages, and risk ratios were determined for all demographic characteristics. Minnesota has a large Somali-born population; therefore, this group was analyzed separately from women born in all other African countries. Chi square tests and t-tests were used to test for significance. Because of the size of the cohort, statistical significance was set at $p<0.001$. Among women who received Tdap vaccine during their pregnancy, the percentage vaccinated during the optimal recommended time frame for vaccination (27–36 weeks gestation) (*3*) was also determined. The study was reviewed and approved by the University of Minnesota's Institutional Review Board.

Among 127,073 live births in Minnesota with available and complete vital records for the period March 2, 2013–December 31, 2014, a total of 113,730 (89.5%) were matched to MIIC records. Among these women, 66,222 (58.2%) had received at least one Tdap vaccine, and 52,248 (45.9%) had received at least one influenza vaccine during pregnancy (Table 1). Among

*The Kotelchuck Index considers adequate prenatal care as the initiation of prenatal care by the 4th month of pregnancy and attendance at ≥80% of prenatal care visits recommended by the American College of Obstetricians and Gynecologists (ACOG). Intermediate prenatal care is considered the initiation of prenatal care by the 4th month of pregnancy and attendance at ≥50% of recommended visits. Inadequate prenatal care is considered as starting prenatal care after the 4th month of pregnancy or attendance at <50% of recommended visits. This analysis considered all pregnancies to be normal and did not account for groups at high risk. The Kotelchuck Index also considered prenatal care to be adequate plus if >110% of visits were attended, but this level of care was not included in the analysis.

TABLE 1. Tdap and influenza vaccination coverage among pregnant women, based on vital records data and immunization records — Minnesota, March 2, 2013–December 31, 2014

Characteristic	Total study population No. (%)	Received Tdap vaccination during pregnancy No. (%)	Received Influenza vaccination during pregnancy No. (%)
Overall	**113,730**	**66,222 (58.2)**	**52,248 (45.9)**
Maternal race			
White	88,209 (77.6)	51,765 (58.7)	41,362 (46.9)
Black	12,192 (10.7)	6,785 (55.7)	4,756 (39.0)
American Indian	2,174 (1.9)	1,025 (47.2)	852 (39.2)
Asian Indian	1,658 (1.5)	1,020 (61.5)	796 (48.0)
Asian	6,879 (6.1)	4,124 (60.0)	3,259 (47.4)
Other	2,618 (2.3)	1,503 (57.4)	1,223 (46.7)
Maternal ethnicity			
Non-Hispanic	107,716 (94.7)	62,897 (58.4)	49,559 (46.0)
Hispanic	6,014 (5.3)	3,325 (55.3)	2,709 (45.0)
Maternal birth country/region*			
United States	95,889 (84.3)	56,497 (58.9)	44,833 (46.8)
Africa (excluding Somalia)	6,750 (5.9)	3,424 (50.7)	2,494 (37.0)
Somalia	3,402 (3.4)	1,370 (40.3)	1,370 (40.3)
Western Europe/Canada	974 (0.9)	508 (52.2)	392 (40.3)
Asia	6,657 (5.9)	3,896 (58.5)	3,053 (45.9)
Central and South America/Mexico	2,460 (2.2)	1,473 (59.9)	1,209 (49.2)
Eastern Europe	787 (0.7)	303 (38.5)	185 (23.5)
Other	165 (0.2)	99 (60.0)	59 (35.8)
Mother's education level			
<High school diploma or GED	10,074 (9.0)	5,352 (53.1)	4,169 (41.4)
High school diploma or GED	18,665 (16.6)	10,476 (56.1)	8,061 (43.2)
<4 yrs college	22,158 (19.7)	12,781 (57.7)	9,666 (43.6)
Bachelor's/Associate's	46,688 (41.5)	27,879 (59.7)	22,341 (47.9)
Master's/PhD/ professional	14,878 (13.2)	9,284 (62.4)	7,669 (51.6)
Marital status			
Married	77,135 (68.0)	44,287 (57.4)	35,567 (46.1)
Not married	36,281 (32.0)	21,927 (60.4)	16,673 (47.0)
Payment			
Private	74,053 (65.5)	44,559 (60.2)	35,714 (48.2)
Military	1,114 (1.0)	673 (60.4)	505 (45.3)
Uninsured	2,499 (2.2)	781 (31.3)	661 (26.5)
Medical assistance	33,629 (29.7)	19,111 (56.8)	14,460 (43.0)
Other	1,778 (1.6)	1,014 (57.0)	845 (47.5)
Adequacy of prenatal care†			
Adequate	87,094 (76.6)	53,281 (61.2)	42,314 (48.6)
Intermediate	13,241 (11.6)	7,079 (53.5)	5,759 (43.5)
Inadequate	13,395 (11.8)	5,862 (43.8)	3,700 (32.3)
Received WIC			
Yes	36,700 (32.6)	21,268 (58.0)	16,543 (45.1)
No	76,014 (67.4)	44,685 (58.8)	35,488 (46.7)

Abbreviations: GED = general educational development certificate; Tdap = tetanus, diphtheria, acellular pertussis vaccine; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

* Missing values for maternal birth country (n = 48), education (n = 1,267), marital status (n = 314), payment (n = 657), WIC status (n = 1,016).

† Based on the Kotelchuck Index, which considers time of initiation of prenatal care and number of prenatal visits attended.

women who received Tdap vaccine, 57,215 (86.4%) were vaccinated during the recommended period (27–36 weeks gestation).

Unadjusted risk ratios for Tdap and influenza vaccinations were calculated across selected demographic characteristics. Tdap and influenza vaccination coverage rates were significantly lower among pregnant women who received inadequate or intermediate prenatal care compared with women who received adequate prenatal care. Rates were also significantly lower among black and American Indian women when compared with white women, and among women born in Africa (particularly Somalia), Eastern Europe, Western Europe, and Canada compared with women born in the United States. In addition, vaccination coverage was lower among Hispanic women than non-Hispanic women (for Tdap only), women with lower levels of education, and women who were receiving medical assistance, or were uninsured (Table 2).

TABLE 2. Unadjusted relative risks for Tdap and influenza vaccination during pregnancy by selected demographic characteristics — Minnesota births, March 2, 2013–December 31, 2014

Characteristic	Tdap vaccination unadjusted relative risk % (95% CI)	Influenza vaccination unadjusted relative risk % (95% CI)
Maternal race (referent = white)		
Black	0.95* (0.93–0.96)	0.83* (0.81–0.85)
American Indian	0.80* (0.77–0.84)	0.84* (0.79–0.88)
Asian Indian	1.05 (1.01–1.09)	1.02 (0.97–1.08)
Asian	1.02 (1.00–1.04)	1.01 (0.98–1.04)
Maternal ethnicity (referent = non-Hispanic)		
Hispanic	0.95* (0.93–0.97)	0.98 (0.95–1.01)
Maternal birth country/region (referent = United States)		
Africa (excluding Somalia)	0.86* (0.84–0.88)	0.79* (0.77–0.82)
Somalia	0.68* (0.66–0.71)	0.58* (0.55–0.61)
Western Europe/Canada	0.89* (0.83–0.94)	0.86* (0.80–0.93)
Asia	0.99 (0.97–1.01)	0.98 (0.95–1.01)
Central and South America/Mexico	1.02 (0.98–1.05)	1.05 (1.01–1.09)
Eastern Europe	0.65* (0.60–0.71)	0.50* (0.44–0.57)
Mother's education level (referent = bachelor's/associate's degree)		
<High school diploma or GED	0.89* (0.87–0.91)	0.86* (0.84–0.89)
High school diploma or GED	0.94* (0.93–0.95)	0.90* (0.89–0.92)
<4 yrs college	0.97* (0.95–0.98)	0.91* (0.90–0.93)
Master's/PhD/professional degree	1.05* (1.03–1.06)	1.08* (1.06–1.10)
Married (referent = yes)		
No	1.05* (1.04–1.06)	1.00 (0.98–1.01)
Payment (referent = private insurance)		
Military	1.00 (0.96–1.03)	0.94 (0.88–1.00)
Uninsured	0.52* (0.49–0.55)	0.55* (0.51–0.59)
Medical assistance	0.94* (0.93–0.95)	0.89* (0.88–0.90)
Prenatal care† (referent = adequate)		
Intermediate	0.87* (0.86–0.89)	0.90* (0.88–0.91)
Inadequate	0.71* (0.70–0.73)	0.67* (0.65–0.68)
Received WIC (referent = no)		
Yes	1.01 (1.00–1.03)	1.04* (1.02–1.05)

Abbreviations: GED = general educational development certificate; Tdap = tetanus, diphtheria, acellular pertussis vaccine; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.
* p <0.001.
† Based on the Kotelchuck Index, which considers time of initiation of prenatal care and number of prenatal visits attended.

Discussion

Healthy People 2020 goals include decreasing the number of infant pertussis cases by 10% and increasing influenza vaccination coverage among pregnant women (*5*). Although it is not possible to assess progress on the infant pertussis goal using only maternal Tdap vaccination data, influenza vaccination coverage of 46% among pregnant women in Minnesota is well below the overall *Healthy People 2020* goal of 70% of adults aged ≥18 years receiving seasonal influenza vaccine (*5*). Suboptimal coverage levels might be related to the quality of prenatal care and concerns about vaccine safety during pregnancy. One study found that women who were generally supportive of vaccines expressed concern over vaccines given during pregnancy (*6*). Another study found that 67% of patients accepting the monovalent influenza 2009 H1N1 vaccine said their obstetrician's recommendation was a major factor in their decision (*7*). According to an Internet panel survey conducted during March–April 2014, influenza vaccination coverage among pregnant women who received a provider recommendation and offer for influenza vaccination was more than twice as high as coverage among women who received a recommendation but no offer, and seven times higher than coverage among women who received no recommendation and no offer (*8*).

This study demonstrates demographic disparities in Tdap and influenza vaccination coverages among pregnant women in Minnesota, including by race, maternal birth country or region, maternal educational attainment, insurance coverage at delivery, and adequacy of prenatal care. Additional studies are needed to identify barriers to vaccination faced by women in different demographic groups to inform the development of effective strategies to address these disparities.

The findings in this report are subject to at least four limitations. First, because submitting immunization data to MIIC was not required for health care providers in Minnesota at the time of this study, some MIIC records might be incomplete and some Minnesota residents might not be in MIIC. Therefore, actual vaccine coverage might be different than results suggest. Second, self-reported demographic data and

Summary

What is already known about this topic?

The Advisory Committee on Immunization Practices recommends that women who are or will be pregnant during the influenza season be vaccinated with inactivated influenza virus vaccine, and that all pregnant women receive a dose of tetanus, diphtheria, acellular pertussis (Tdap) vaccine in every pregnancy. Vaccination during pregnancy protects infants from influenza and pertussis during the first year of life through passively acquired maternal antibodies.

What is added by this report?

Among 113,730 women in Minnesota who had delivered a live birth during March 2013–December 2014 and for whom immunization records were available, 58% received a Tdap vaccination and 46% received an influenza vaccination during their pregnancy. Tdap and influenza coverage rates were significantly lower among pregnant women who received inadequate or intermediate prenatal care; black and American Indian women; women born in Africa (particularly Somalia), Eastern Europe, and Western Europe or Canada; women with lower levels of education; and women who were receiving medical assistance or who were uninsured, than among women who received adequate prenatal care, were white, U.S.-born, had higher levels of education, and had private insurance.

What are the implications for public health practice?

Measures are needed to improve adequacy of prenatal care and reduce health disparities among minority, poor, and non–U.S.-born women to address maternal vaccination disparities.

inconsistent reporting of prenatal care data across different health care facilities might result in data misclassification. The Office of Vital Records data are self-reported by birth parents, with the exception of prenatal care data, which are completed by health care facilities. Misclassification could potentially result in artificial demographic disparities. Third, the start date of the study was 1 week after publication of the current ACIP recommendation for Tdap vaccination during pregnancy. Because it takes time for health care providers to become familiar with and begin implementing new vaccine recommendations, it is likely that initial coverage rates were low because prenatal care providers were unaware of the new recommendation, or because their clinical practice guidelines had not yet been updated. Although rates might have been lower at the beginning of the study period for these reasons, from 2013 to 2014, Tdap vaccination coverage during pregnancy increased 16.8%, suggesting that more prenatal care providers adopted the new recommendation as they became aware of it. Finally, this study assessed whether a pregnant woman received at least one influenza vaccine during her pregnancy. If a pregnancy spanned two influenza seasons, women might have only received one vaccine, which would not provide optimal protection because of annual strain selection changes made to the vaccine. Therefore, this study might not accurately represent protection against the circulating influenza strains among pregnant women.

Studies have demonstrated the positive impact of a strong provider recommendation for vaccination (*6*–*8*); however, more information is needed to understand the factors that influence strong recommendations, such as the time and training required to adopt and implement them. Addressing these factors will help providers make strong vaccine recommendations during prenatal care visits. Future studies also are needed to assess the timing of influenza vaccination during pregnancy to better understand whether pregnant women are being appropriately vaccinated over consecutive influenza seasons. In addition, further investigation into reasons for lower vaccination coverage among certain racial and ethnic groups need to be explored to assist public health professionals and clinicians in addressing community-specific barriers to maternal vaccination.

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Notes from the Field

Use of Social Media as a Communication Tool During a Mumps Outbreak — New York City, 2015

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On August 16, 2015, a case of parotitis in a resident of the Rockaways neighborhood of Queens, New York City (NYC), was reported to the NYC Department of Health and Mental Hygiene (DOHMH) as a suspected mumps case. Subsequent investigations by DOHMH discovered an outbreak of mumps in the Rockaways, with 52 confirmed and probable mumps cases. DOHMH conducted a Facebook advertisement campaign providing information about mumps and the outbreak, which was targeted to Facebook users in the Rockaways neighborhood. The advertisement was shown to 86,111 persons during an approximately 2-week period and provided a timely and inexpensive means of effectively communicating with a large, targeted population.

After the case of parotitis was reported on August 16, 2015, DOHMH identified two additional cases through investigation of the patient's close contacts. These cases were the first indication to DOHMH of a mumps outbreak in the Rockaways. Because the first patient mentioned other persons in the neighborhood with parotitis, DOHMH contacted health care providers in the Rockaways for information about other patients with parotitis and any mumps laboratory testing not previously reported.

DOHMH conducted investigations through interviews and review of medical records. Diagnostic testing included identification of mumps immunoglobulin M (IgM) in serum and detection of mumps virus RNA by real-time reverse–transcription polymerase chain reaction (rRT-PCR) of buccal swabs. DOHMH used criteria from the Council of State and Territorial Epidemiologists to classify cases as confirmed, probable, or discarded (*1*). Cases were identified through routine provider and laboratory reports to DOHMH; six additional cases were identified through retrospective case finding. Although mumps is a nationally notifiable disease, providers had not reported these cases to DOHMH because they did not suspect mumps or because IgM testing was negative and rRT-PCR testing was not done.

Overall, the outbreak included 52 confirmed and probable mumps cases, with illness onset from June 19–November 2, 2015. Forty-seven patients lived in the Rockaways, and five lived elsewhere in NYC. Two patients who lived outside NYC were not included in this analysis. Median age of mumps patients was 31 years (range = 4–69 years); all but two were adults aged ≥18 years. No patients were hospitalized or had complications. Among the 50 cases for which laboratory testing was conducted, 32 (64%) tested positive by any test, including 29 (66%) of 44 tested by rRT-PCR, and seven (15%) of 47 tested for IgM. Twenty-five (48%) patients had evidence of prior immunity (2 documented doses of mumps-containing vaccine, positive immunoglobulin G titers, or birth before 1957), and immune status of 27 (52%) patients was unknown. Twenty-two patients reported having attended several common neighborhood bars and restaurants during either their incubation or infectious period. Initial control measures implemented during August–November, 2015, included home isolation of infectious patients, notifications to health care providers in the Rockaways, provision of vaccine to two local clinics for administration at no cost, and distribution of informational posters and flyers throughout the neighborhood, specifically targeting the common bars and restaurants attended by patients.

Because DOHMH continued to receive mumps reports from the Rockaways during October despite usual control measures, DOHMH conducted a Facebook advertisement campaign targeted to Facebook users aged 20–59 years in the Rockaways zip codes, as determined by accounts' home addresses, Internet Protocol addresses used to access the Internet, or locations of mobile devices. The advertisement provided information about mumps and the outbreak and instructed persons with symptoms to stay home, and was shown to 86,118 unique persons during its run (October 30–November 17, 2015). It was clicked on 4,085 times and received 954 likes, 297 comments, and 843 shares, which was more shares than any other DOHMH post at that time. The $3,200 cost was less than that for traditional print media, and the advertisement could be placed quickly and removed once the outbreak had concluded. DOHMH responded to commenter questions in real time, necessitating the availability of DOHMH personnel to respond quickly. Social media provided a timely and inexpensive means for successfully and rapidly communicating with a large population in the target demographic and facilitating public engagement with DOHMH about the mumps outbreak, and therefore, might be useful for disseminating messages to a targeted population during future outbreaks.

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Notes from the Field

Hantavirus Pulmonary Syndrome in a Migrant Farm Worker — Colorado, 2016

Grace Marx, MD[1,2]; Kaylan Stinson, MSPH[2]; Monte Deatrich, MA[2]; Bernadette Albanese, MD[2]

On August 8, 2016, Tri-County Health Department (Adams, Arapahoe, and Douglas counties) in Colorado was notified of a confirmed case of hantavirus pulmonary syndrome (HPS). The patient was a previously healthy male migrant farm worker aged 25 years, living in farm quarters, and working in vegetable fields for 8 weeks before symptom onset. On July 20, he experienced sudden onset of fever, severe headache, myalgias, cough, and nosebleed. He was evaluated at an emergency department on July 23, where his temperature was 103.9°F (40.0°C), and his physical exam was notable for bronchial breath sounds and pulmonary crackles. Chest radiograph revealed bilateral interstitial infiltrates and small pleural effusions, and thrombocytopenia (47,000/μL) was a noted laboratory finding. The patient was hospitalized for 3 days, required minimal oxygen and supportive care, and survived. Serology obtained on hospital admission was positive for hantavirus immunoglobulin M (IgM) and immunoglobulin G antibodies, with a positive result for Sin Nombre virus (SNV) (the primary etiologic agent of HPS in the United States) IgM at 1:6400, consistent with acute infection (Table).

Hantaviruses are a genus within the Bunyaviridae family that can cause HPS, a rare and sometimes fatal respiratory disease in humans. The majority of HPS cases in the United States are caused by SNV, which is primarily transmitted by the deer mouse (*Peromyscus maniculatus*) (*1*). The average incubation period is 1–5 weeks after exposure to infected deer mouse urine or droppings (*2*). HPS typically manifests with fever, myalgias, progressive respiratory insufficiency, thrombocytopenia, and leukocytosis. Treatment is supportive. Approximately 60% of hospitalized patients experience pulmonary edema and respiratory failure and require mechanical ventilation (*3*). HPS case-fatality ratio is 38% (*4*).

TABLE. Laboratory findings associated with hantavirus pulmonary syndrome and Sin Nombre virus infection in a patient, by specimen collection date — Colorado, July 2016

Clinical specimen and laboratory test	Reference range	Collection date		
		July 23	July 24	July 26
Hantavirus IgM antibodies (ELISA)*	<2.00	—†	7.13	—†
Hantavirus IgG antibodies (ELISA)*	<2.00	—†	10.05	—†
Sin Nombre virus IgM antibodies (ELISA)§	<1:100	—†	1:6400	—†
Sin Nombre virus IgG antibodies (ELISA)§	<1:100	—†	1:100	—†
Sin Nombre virus IgM antibodies (ELISA)*,¶	<0.80	—†	4.83; 4.01	—†
White blood cells ($10^3/\mu$L)	4.8–10.8	7	8.9	9.4
Hematocrit (%)	42.0–52.0	49	44	43
Platelets ($10^3/\mu$L)	130–400	47	59	144

Abbreviations: ELISA = enzyme-linked immunosorbent assay; IgG = immunoglobulin G; IgM = immunoglobulin M.
* Commercial reference laboratory.
† Data not collected.
§ Colorado State Department of Public Health and Environment laboratory.
¶ Confirmatory reflex testing was performed twice.

In Tri-County Health Department performed an environmental assessment of the farm on August 17. The residential dwelling was shared with 12 other male farm workers in a 1,000 square-foot wood frame house. Open food containers were found throughout the house; rodent droppings were observed in the kitchen, cement foundation, and ceiling. The patient reported that during the incubation period, he took daytime naps under trees and in abandoned farm buildings on the property, information that was corroborated by the farm owner and foreman. Those napping areas had evidence of rodent habitation including nesting, burrowing, and rodent runs. None of the other housemates reported an acute respiratory illness during the same exposure period and were not medically evaluated. Tri-County Health Department recommended implementing an integrated pest management program in the residential dwelling and workplace, which the farm owner agreed to execute.

Review of HPS cases in Tri-County Health Department's jurisdiction during the preceding 2 years revealed a fatal case in a farm worker in November 2014 (Colorado Electronic Disease Reporting System, unpublished data, 2016) on a ranch approximately 50 miles east of the farm described in this report. Environmental assessment of that patient's farm home in 2014 revealed multiple rodent nests and excrement throughout the rural residential dwellings.

This report highlights the importance of considering HPS in farm workers and in other occupations with risk for rodent exposure either at the workplace or in housing provided by the employer (*5*,*6*). Nationally, 23% of reported HPS cases with a reported occupation were working in agriculture (Dr. Annabelle de St. Maurice, CDC, personal communication, 2016). The lack of a vaccine or specific treatment for HPS underscores the importance of focusing on behavioral and environmental risk reduction to prevent SNV infections, including for at-risk occupations, such as farming. Adding supplemental questions to the national HPS case report form*

* https://www.cdc.gov/hantavirus/pdf/hps_case-report-form.pdf.

about occupational exposures, including occupation, industry, workplace, and work-related housing or other outdoor activities, will improve identification of work practices and characteristics that increase risk for SNV exposure. Rapid public health assessment of environmental exposure to SNV is critical to mitigate ongoing hazards.

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Notice to Readers

MMWR Rural Health Series

During 2017, *MMWR* will publish several Surveillance Summaries on topics that highlight rural health issues. The *MMWR* Rural Health Series is available at https://www.cdc.gov/mmwr/rural_health_series.html. Two recently published reports (*1*,*2*) described the death rate and number of potentially excess deaths from the five leading causes of death in the United States.

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1. Moy E, Garcia MC, Bastian B, et al. Leading causes of death in nonmetropolitan and metropolitan areas—United States, 1999–2014. MMWR Surveill Summ 2017;66(No. SS-1). http://dx.doi.org/10.15585/mmwr.ss6601a1
2. Garcia MC, Faul M, Massetti G, et al. Reducing potentially excess deaths from the five leading causes of death in the rural United States. MMWR Surveill Summ 2017;66(No. SS-2). http://dx.doi.org/10.15585/mmwr.ss6602a1

Errata

Vol. 65, No. 50-51

In the report "Characteristics of Electronic Cigarette Use Among Middle and High School Students — United States, 2015," in the table on page 1426, the percentage and confidence interval for females using only disposable types of e-cigarettes should have been 15.4 (12.6–**18.7**).

Vol. 65, No. 50-51

In the report "Outbreak of *Salmonella* Oslo Infections Linked to Persian Cucumbers — United States, 2016," the footnote on page 1430 should have read **"† https://www.cdc.gov/foodnet/surveys/population.html."**

Vol. 65, No. 52

In the report "Zika Virus —10 Public Health Achievements in 2016 and Future Priorities," on page 1482, the first sentence under the heading "3. Identifying Sexual Transmission of Zika Virus Infection," should have read "In late January, CDC, in collaboration with Texas health officials, **worked to confirm** sexual contact as the source of Zika virus infection in a Dallas man whose partner had traveled to **Venezuela** (*14*) and issued guidance for the prevention of sexual transmission of Zika virus in February (*15*)."

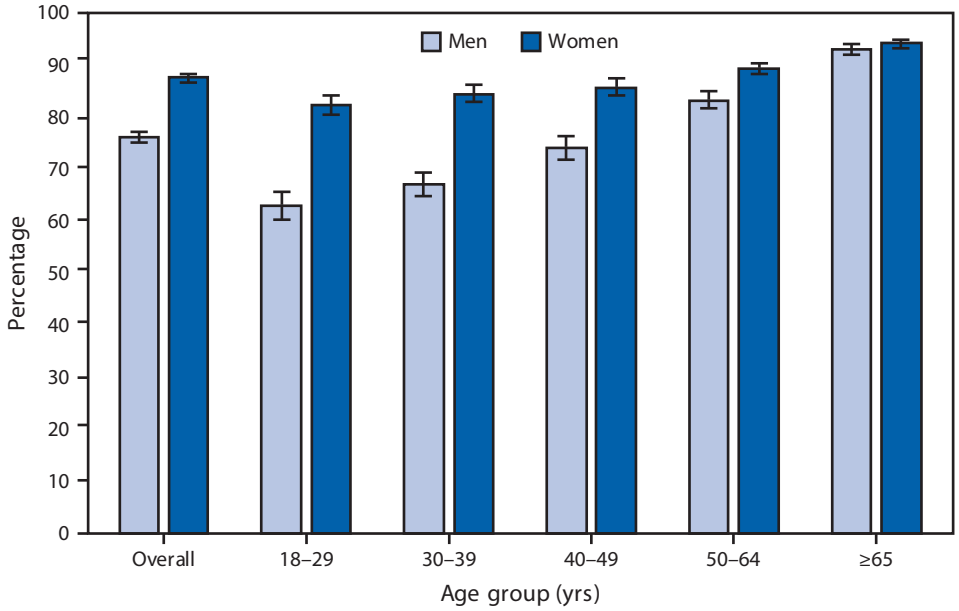
Vol. 65, Suppl. 3

In the report "Safe and Effective Deployment of Personnel to Support the Ebola Response—West Africa," which was part of the supplement entitled "CDC's Response to the 2014–2016 Ebola Pandemic—West Africa and United States," the following author was omitted from the listing on the first page: **Jacqueline R. Burkholder, PhD, Division of Emergency Operations, Office of Public Health Awareness, CDC.**

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Adults Aged ≥18 Years Who Have Seen or Talked to a Doctor or Other Health Care Professional About Their Own Health in the Past 12 Months,† by Sex and Age Group — National Health Interview Survey,§ United States, 2015



* With 95% confidence intervals indicated with error bars.
† Based on a question that asked "About how long has it been since you last saw or talked to a doctor or other health care professional about your own health? Include doctors seen while a patient in the hospital." The response categories "6 months or less" and "More than 6 mos, but not more than 1 year ago" were combined for this chart.
§ Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population and are derived from the National Health Interview Survey Sample Adult component.

In 2015, women aged ≥18 years were more likely than men, overall and for each age group except those aged ≥65 years, to have seen or talked to a doctor or other health professional about their own health in the past 12 months. For both sexes, visits to a doctor or other health care professional increased with age, from 63.1% among men aged 18–29 years to 93.2% among men aged ≥65 years and from 82.4% among women aged 18–29 years to 94.3% among women ≥65 years.

Source: National Health Interview Survey, 2015. https://www.cdc.gov/nchs/nhis/index.htm.

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