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Prevalence of Asthma, Asthma Attacks, and Emergency Department Visits for Asthma Among Working Adults — National Health Interview Survey, 2011–2016

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In 2010, an estimated 8.2% of U.S. adults had current asthma, and among these persons, 49.1% had had an asthma attack during the past year (*1*). Workplace exposures can cause asthma in a previously healthy worker or can trigger asthma exacerbations in workers with current asthma* (*2*). To assess the industry- and occupation-specific prevalence of current asthma, asthma attacks, and asthma-related emergency department (ED) visits among working adults, CDC analyzed 2011–2016 National Health Interview Survey (NHIS) data for participants aged ≥18 years who, at the time of the survey, were employed at some time during the 12 months preceding the interview. During 2011–2016, 6.8% of adults (11 million) employed at any time in the past 12 months had current asthma; among those, 44.7% experienced an asthma attack, and 9.9% had an asthma-related ED visit in the previous year. Current asthma prevalence was highest among workers in the health care and social assistance industry (8.8%) and in health care support occupations (8.8%). The increased prevalence of current asthma, asthma attacks, and asthma-related ED visits in certain industries and occupations might indicate increased risks for these health outcomes associated with workplace exposures. These findings might assist health care and public health professionals in identifying workers in industries and occupations with a high prevalence of current asthma, asthma attacks, and asthma-related ED visits who should be evaluated for possible work-related asthma. Guidelines intended to promote effective management of work-related asthma are available (*2*,*3*).

The NHIS is an annual survey that collects health information from a nationally representative sample of the noninstitutionalized U.S. civilian population through personal interviews.† Survey participants were considered to be working in the last 12 months if they reported having a job or business at any time during the past 12 months.§ For analyses, information on respondents' current industry (21 major groups/79 detailed industries) and occupation (23 major groups/94 detailed occupations) were used.¶ Participants who had ever been told by a doctor or other health professional that they had asthma and reported that they still have asthma were considered to have current asthma. Persons with at

* Work-related asthma is defined as either occupational asthma (i.e., new-onset asthma caused by factors related to work) or work-exacerbated asthma (i.e., preexisting or concurrent asthma worsened by factors related to work).

† https://www.cdc.gov/nchs/nhis/quest_data_related_1997_forward.htm.

§ ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2014/samadult_layout.pdf.

¶ Industry and occupation information that employed sample adults had during the week before the interview. Additional information on the industry and occupation coding schemes can be found at ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2014/srvydesc.pdf.

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least one asthma attack in the past year, or at least one asthma-related ED visit in the past year were identified by affirmative responses to questions "During the past 12 months, have you had an episode of asthma or an asthma attack?" and "During the past 12 months, have you had to visit an emergency room or urgent care center because of asthma?," respectively.

Data were weighted to produce nationally representative estimates using sample weights, and variance estimates were calculated to account for the clustered survey design. Estimates with a relative standard error (standard error of the estimate divided by the estimate) ≥30% were not reported. The Rao-Scott chi-square test was used to determine statistically significant differences ($p<0.05$) between groups. Data were analyzed using statistical software.

During 2011–2016, an estimated (annual average) 160.7 million adults were working at any time during the past 12 months (Table 1), 6.8% (11.0 million) of whom had current asthma. Current asthma prevalence was highest among workers aged 18–24 years (8.5%), females (8.9%), non-Hispanic blacks (8.2%), those with higher than a high school education (7.2%), those categorized as "poor"** (8.7%), those having health insurance (7.1%), and those living in the Northeast (7.6%).

** Poverty index is based on family income and family size using the U.S. Census Bureau's poverty thresholds for the previous calendar year. Persons categorized as "poor" have family incomes <100% of the poverty threshold, "near poor" have family incomes ≥100% to <200% of the poverty threshold, "not poor" have family incomes ≥200% of the poverty threshold. ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2016/srvydesc.pdf, https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html.

Among workers with current asthma, 44.7% (4.9 million) had at least one asthma attack, and 9.9% (1.1 million) had at least one asthma-related ED visit in the past 12 months (Table 1). The proportion of workers with current asthma who had at least one asthma attack was highest among workers aged 45–64 years (47.4%), females (48.4%), non-Hispanic whites (45.4%), those with higher than a high school education (45.2%), those categorized as poor (49.2%), those with no health insurance (47.5%), and those living in the South (46.1%). The proportion of workers with current asthma who had at least one asthma-related ED visit was highest among workers aged 18–24 years (10.5%), females (11.7%), non-Hispanic blacks (17.6%), those with less than high school education (13.3%), those categorized as poor (17.0%), those with no health insurance (14.5%), and those living in the South (11.3%).

By major industry, current asthma prevalence was highest among workers in the major industry groups of health care and social assistance (8.8%) followed by educational services (8.2%) (Table 2); these groups also had the first and second highest numbers of workers with asthma attacks (860,000 and 602,000, respectively) and asthma-related ED visits (212,000 and 102,000, respectively). The highest prevalence of asthma attacks was among workers with asthma in the transportation and warehousing (51.7%) industries, and the highest prevalence of asthma-related ED visits was among workers in retail trade (12.4%).

By detailed industry sector, current asthma prevalence was highest among workers in electronics and appliance stores (11.9%) (Table 2). Among persons with current asthma, the

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TABLE 1. Current asthma* prevalence and proportion of adults working at any time in the past 12 months† with current asthma who had at least one asthma attack§ or emergency department (ED) visit for asthma¶ in the past 12 months (annual average), by selected characteristics — National Health Interview Survey, 2011–2016

Characteristic	Workers (x 1,000)**	Current asthma			Proportion of persons with current asthma who had ≥1 asthma attack in past 12 months		Proportion of persons with current asthma who had ≥1 asthma ED visit in past 12 months	
		No. (x 1,000)**	% (95% CI)	p-value	% (95% CI)	p-value	% (95% CI)	p-value
Age group (yrs)								
18–24	22,005	1,858	8.5 (7.8–9.1)	<.001	36.8 (33.3–40.3)	<.001	10.5 (8.0–13.0)	0.30
25–44	68,651	4,529	6.6 (6.3–6.9)		46.2 (44.1–48.4)		10.4 (9.2–11.7)	
45–64	60,927	4,072	6.7 (6.4–7.0)		47.4 (45.2–49.5)		9.3 (8.1–10.5)	
≥65	9,126	513	5.6 (5.0–6.2)		40.6 (34.4–45.8)		8.0 (5.5–10.5)	
Sex								
Men	84,415	4,181	5.0 (4.7–5.2)	<.001	39.0 (36.6–41.4)	<.001	7.0 (5.9–8.2)	<.001
Women	76,294	6,791	8.9 (8.6–9.2)		48.4 (46.7–50.1)		11.7 (10.6–12.8)	
Race/Ethnicity								
Hispanic	25,359	1,272	5.0 (4.7–5.4)	<.001	44.9 (41.1–48.7)	0.51	15.7 (12.7–18.7)	<.001
Non-Hispanic white	106,291	7,667	7.2 (7.0–7.5)		45.4 (43.7–47.1)		7.6 (6.7–8.5)	
Non-Hispanic black	18,770	1,542	8.2 (7.7–8.8)		42.5 (38.9–46.0)		17.6 (14.9–20.3)	
Other	10,289	490	4.8 (4.2–5.4)		42.9 (37.0–48.9)		7.1 (3.9–10.3)	
Education level								
≤High school	52,305	3,255	6.2 (5.9–6.5)	<.001	43.8 (41.3–46.3)	0.62	13.3 (11.6–15.0)	<.001
>High school	107,813	7,697	7.2 (6.9–7.4)		45.2 (43.6–46.9)		8.5 (7.6–9.4)	
Unknown	591	—††	—		—		—	
Poverty index§§								
Poor	14,335	1,251	8.7 (8.1–9.3)	<.001	49.2 (45.5–52.9)	<.001	17.0 (14.3–19.5)	<.001
Near poor	23,012	1,617	7.0 (6.6–7.5)		44.3 (40.7–47.9)		12.8 (10.5–15.1)	
Not poor	114,200	7,544	6.6 (6.4–6.8)		44.2 (42.5–45.9)		7.9 (6.9–8.8)	
Unknown	9,163	560	6.2 (5.4–6.9)		44.5 (38.1–50.9)		13.5 (9.5–17.6)	
Health insurance status								
Not insured	24,577	1,344	5.5 (5.1–5.9)	<.001	47.5 (43.3–51.6)	0.34	14.5 (12.0–17.1)	<.001
Insured	135,328	9,576	7.1 (6.9–7.3)		44.5 (43.1–45.9)		9.3 (8.4–10.2)	
Unknown	804	52	6.4 (3.4–9.0)		—		—	
Region								
Northeast	28,621	2,182	7.6 (7.2–8.1)	<.001	43.0 (40.5–45.4)	0.22	8.2 (6.5–9.9)	0.38
Midwest	37,804	2,679	7.1 (6.7–7.5)		43.7 (40.7–46.7)		8.9 (7.1–10.6)	
South	57,064	3,483	6.1 (5.8–6.4)		46.1 (43.5–48.8)		11.3 (9.7–12.9)	
West	37,220	2,628	7.1 (6.7–7.4)		45.7 (42.8–48.6)		10.6 (8.9–12.4)	
Total	**160,709**	**10,972**	**6.8(6.7–7.0)**		**44.7 (43.3–46.1)**		**9.9 (9.1–10.7)**	

Abbreviation: CI = confidence interval.

* Defined as a "yes" response to the questions "Have you ever been told by a doctor or other health professional that you had asthma?" and "Do you still have asthma?"

† Survey respondents who answered "yes" to the question "Did you have a job or business at any time in the past 12 months?"

§ Defined as a "yes" response to the question "During the past 12 months, have you had an episode of asthma or an asthma attack?"

¶ Defined as a "yes" response to the question "During the past 12 months, have you had to visit an emergency room or urgent care center because of asthma?"

** Weighted to provide national estimates.

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

§§ Poverty index is based on family income and family size using the U.S. Census Bureau's poverty thresholds for the previous calendar year. Persons who are categorized as "poor" have family incomes <100% of the poverty threshold, "near poor" have family incomes ≥100% to <200% of the poverty threshold, and "not poor" have family incomes ≥200% of the poverty threshold. ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2016/srvydesc.pdf, https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html.

highest asthma attack prevalence was among workers in wood products manufacturing (57.3%), followed by the plastics and rubber products manufacturing (56.7%), and the highest prevalence of asthma-related ED visits was among workers in private households (22.9%). The highest numbers of asthma attacks (307,000) and asthma-related ED visits (75,000) were among persons working in ambulatory health care services.

By major occupation group, current asthma prevalence was highest among workers in health care support (8.8%), followed by personal care and service (8.6%) occupations (Table 3). Among those with current asthma, the highest prevalence of asthma attacks was among workers in the education, training, and library (51.5%) major occupations; the highest prevalence of asthma-related ED visits was among workers in personal care and service (17.4%) occupations. The highest numbers of workers with asthma attacks (711,000) and asthma-related ED visits (137,000) were in the office and administrative support major occupation.

TABLE 2. Current asthma* prevalence and proportion of adults working at any time in the past 12 months† with current asthma who had at least one asthma attack§ or emergency department (ED) visit for asthma¶ in the past 12 months (annual average), by industry — National Health Interview Survey, 2011–2016**

Industry	Workers (x 1,000)††	Current asthma		Proportion of persons with current asthma who had ≥1 asthma attack in past 12 months	Proportion of persons with current asthma who had ≥1 asthma ED visit in past 12 months
		No. (x 1,000)††	% (95% CI)	% (95%CI)	% (95% CI)
Health care and social assistance	21,270	1,878	8.8 (8.3–9.4)	45.8 (42.8–49.1)	11.3 (9.3–13.2)
Ambulatory health care services	8,135	710	8.7 (7.9–9.6)	43.2 (38.2–48.1)	10.5 (7.4–13.6)
Hospitals	6,693	551	8.2 (7.3–9.2)	51.7 (46.0–57.4)	10.1 (6.6–13.7)
Nursing and residential care facilities	2,978	262	8.8 (7.4–10.2)	45.2 (36.0–54.3)	13.8 (8.0–19.6)
Social assistance	3,463	355	10.3 (8.8–11.8)	42.9 (35.4–50.5)	12.3 (8.1–16.5)
Education services	15,237	1,243	8.2 (7.5–8.8)	48.4 (44.5–52.3)	8.2 (6.0–10.4)
Arts, entertainment, and recreation	3,569	287	8.1 (6.7–9.4)	50.0 (40.3–59.7)	—§§
Performing arts, spectator sports, and related	1,030	96	9.3 (6.5–12.1)	47.5 (31.0–64.0)	—
Museums, historical sites, and similar institutions	415	30	7.2 (3.6–10.7)	—	—
Amusement, gambling, and recreation	2,124	162	7.6 (5.9–9.4)	54.2 (41.7–66.6)	—
Accommodation and food services	11,233	864	7.7 (6.9–8.5)	40.1 (34.8–45.3)	11.0 (7.9–14.2)
Accommodation	1,737	151	8.7 (6.6–10.9)	51.3 (38.0–64.6)	—
Food services and drinking places	9,496	712	7.5 (6.7–8.4)	37.7 (32.2–43.1)	11.0 (7.5–14.5)
Finance and insurance	7,186	539	7.5 (6.6–8.5)	38.3 (32.4–44.2)	6.0 (3.1–9.0)
Monetary authorities –– central bank	2,122	140	6.6 (5.1–8.1)	31.9 (20.1–43.7)	—
Credit intermediation and related activities	1,197	83	6.9 (5.0–8.9)	46.0 (31.5–60.4)	—
Securities, commodity contracts, and other financial investments and related activities	1,163	80	6.9 (4.6–9.2)	34.8 (18.9–50.6)	—
Insurance carriers and related activities	2,704	237	8.8 (7.1–10.5)	40.6 (31.3–49.9)	—
Retail trade	16,714	1,247	7.5 (6.9–8.1)	46.4 (42.3–50.0)	12.4 (9.6–15.2)
Motor vehicle and parts dealers	1,807	114	6.3 (4.7–7.9)	44.4 (30.3–58.6)	—
Furniture and home furnishings stores	471	29	6.2 (3.1–9.4)	—	—
Electronics and appliance stores	549	65	11.9 (7.9–16.0)	37.8 (19.9–55.8)	—
Building material and garden equipment and supplies dealers	1,277	77	6.0 (4.1–8.0)	46.6 (30.1–63.1)	—
Food and beverage stores	3,241	215	6.7 (5.4–7.9)	45.8 (36.1–55.4)	14.1 (7.2–21.0)
Health and personal care stores	1,241	87	7.0 (4.9–9.1)	47.0 (31.7–62.4)	—
Gasoline stations	608	71	11.8 (7.8–15.7)	47.5 (30.0–65.0)	—
Clothing and clothing accessories stores	1,446	103	7.3 (5.3–9.2)	41.7 (29.0–54.5)	—
Sporting goods, camera, hobby, book and music stores	763	83	10.9 (7.8–13.9)	44.8 (28.8–60.7)	—
General merchandise stores	3,115	237	7.6 (6.1–9.2)	52.8 43.4–62.2)	13.1 (6.0–20.1)
Miscellaneous store retailers	1,140	102	9.0 (6.5–11.5)	50.4 (35.9–64.9)	—
Nonstore retailers and non-specified retail trade	1,057	64	6.0 (4.0–8.0)	45.1 (28.2–61.9)	—
Public administration	7,737	569	7.4 (6.5–8.2)	45.6 (39.1–52.1)	11.6 (6.4–16.7)
Information	3,438	228	6.6 (5.5–7.8)	48.8 (39.6–57.9)	13.1 (6.0–20.1)
Publishing industries (except internet)	702	48	6.9 (4.0–9.7)	51.2 (35.3–67.1)	—
Motion picture and sound recording industries	470	28	6.0 (3.5–8.5)	38.5 (17.1–60.0)	—
Broadcasting and telecommunications	1,742	106	6.1 (4.5–7.6)	49.1 (36.1–62.0)	—
Information services and data processing	524	45	8.7 (5.3–12.0)	51.8 (28.4–75.3)	—
Professional, scientific, and technical services	11,399	738	6.5 (5.8–7.2)	49.2 (44.2–54.1)	8.0 (5.2–10.7)
Administrative & support and waste management & remediation services	7,323	471	6.4 (5.6–7.2)	46.5 (40.4–52.6)	11.6 (8.0–15.3)
Mining	960	59	6.1 (3.9–8.3)	40.2 (21.6–58.8)	—
Oil and gas extraction	102	—	—	—	—
Mining (except oil and gas)	211	—	—	—	—
Support activities for mining	648	40	6.2 (3.4–9.0)	—	—
Other services (except public administration)	8,024	491	6.1 (5.4–6.9)	41.7 (35.3–48.2)	11.1 (7.4–14.9)
Repair and maintenance	2,287	121	5.3 (3.8–6.8)	33.6 (20.5–46.8)	—
Personal services (barber shops, beauty salons, nail salons, laundry, funeral homes and cemeteries)	2,219	117	5.3 (4.1–6.5)	37.4 (26.4–48.3)	16.5 (8.4–24.6)
Religious, grantmaking, civic, labor, professional, and similar organizations	2,486	162	6.5 (5.3–7.8)	44.1 (33.8–55.0)	—
Private households	1,032	91	8.9 (6.3–11.4)	53.2 (37.6–68.7)	22.9 (9.6–36.3)
Utilities	1,390	82	5.9 (4.3–7.6)	34.9 (20.3–49.4)	—

See table footnotes on the next page.

TABLE 2. (*Continued*) Current asthma* prevalence and proportion of adults working at any time in the past 12 months† with current asthma who had at least one asthma attack§ or emergency department (ED) visit for asthma¶ in the past 12 months (annual average), by industry — National Health Interview Survey, 2011–2016**

Industry	Workers (x 1,000)††	Current asthma		Proportion of persons with current asthma who had ≥1 asthma attack in past 12 months	Proportion of persons with current asthma who had ≥1 asthma ED visit in past 12 months
		No. (x 1,000)††	% (95% CI)	% (95%CI)	% (95% CI)
Transportation and warehousing	6,569	383	5.8 (5.0–6.7)	51.7 (43.4–60.0)	11.7 (7.7–15.6)
Transportation (including support activities for transportation)	4,544	245	5.4 (4.6–6.2)	55.1 (46.3–64.0)	14.9 (9.7–20.2)
Postal service, couriers, and messengers	1,460	108	7.4 (4.5–10.4)	44.4 (23.5–65.3)	—
Warehousing and storage	565	30	5.3 (2.8–7.8)	49.8 (25.1–74.5)	—
Manufacturing	16,067	860	5.4 (4.9–5.9)	40.0 (35.2–44.8)	6.7 (4.6–8.9)
Food manufacturing	1,954	104	5.3 (4.1–6.6)	33.1 (21.2–45.0)	—
Beverage and tobacco product manufacturing	301	—	—	—	—
Textile mills	98	—	—	—	—
Textile product mills	138	—	—	—	—
Apparel manufacturing	299	24	8.0 (3.2–12.7)	—	—
Leather and allied product manufacturing	28	—	—	—	—
Wood product manufacturing	447	34	7.7 (3.2–12.2)	57.3 (29.5–85.1)	—
Paper manufacturing	434	22	5.1 (2.2–7.9)	—	—
Printing and related support activities	613	36	5.9 (3.4–8.4)	46.2 (24.41–67.9)	—
Petroleum and coal products manufacturing	138	—	—	—	—
Chemical manufacturing	1,365	59	4.3 (3.1–5.6)	54.6 (31.5–77.6)	—
Plastics and rubber products manufacturing	549	20	3.6 (1.6–5.6)	56.7 (30.0–83.3)	—
Nonmetallic mineral product manufacturing	446	22	4.8 (2.1–7.6)	—	—
Primary metal manufacturing	572	43	7.5 (3.5–11.4)	—	—
Fabricated metal product manufacturing	1,228	55	4.5 (2.9–6.0)	34.0 (17.9–50.2)	—
Machinery manufacturing	1,437	80	5.6 (3.8–7.3)	47.2 (32.8–61.6)	—
Computer and electronic product manufacturing	1,316	70	5.3 (3.9–6.8)	44.1 (30.7–57.5)	—
Electrical equipment, appliance, and component manufacturing	496	32	6.5 (3.4–9.6)	—	—
Transportation equipment manufacturing	2,323	131	5.6 (4.4–6.9)	33.7 (23.1–44.3)	—
Furniture and related product manufacturing	483	26	5.5 (2.7–8.2)	—	—
Miscellaneous manufacturing	1,403	67	4.8 (3.3–6.3)	39.5 (23.9–55.1)	—
Real estate and rental and leasing	3,054	168	5.5 (4.3–6.7)	45.9 (34.9–56.9)	12.5 (4.4–20.5)
Real estate	2,643	142	5.4 (4.2–6.6)	48.7 (37.1–60.3)	14.0 (5.8–22.1)
Rental and leasing services	295	24	8.0 (3.0–11.6)	—	—
Lessors of nonfinancial intangible assets (except copyrighted works)	115	—	—	—	—
Agriculture, forestry, fishing, and hunting	2,358	123	5.2 (4.0–6.5)	38.8 (27.8–49.9)	—
Crop production	1,210	58	4.8 (3.2–6.3)	41.4 (26.8–56.1)	—
Animal production	680	44	6.5 (3.6–9.5)	—	—
Forestry and logging	171	—	—	—	—
Fishing, hunting, and trapping	68	—	—	—	—
Support activities for agriculture and forestry	228	—	—	—	—
Wholesale trade	3,898	192	4.9 (4.0–5.9)	36.7 (27.2–46.2)	—
Merchant wholesalers, durable goods	1,898	87	4.6 (3.1–5.9)	36.6 (21.3–51.9)	—
Merchant wholesalers, nondurable goods	1,963	104	5.3 (3.9–6.8)	37.3 (25.9–49.7)	—
Non-specified wholesale trade	38	—	—	—	—
Construction	10,234	451	4.4 (3.8–5.0)	41.0 (33.8–48.1)	11.3 (6.8–15.9)
Management of companies and enterprises	111	—	—	—	—
Armed forces	360	—	—	—	—
Unknown	2,578	83	3.2 (2.4–4.1)	46.0 (32.3–59.8)	—
Total	**160,709**	**10,972**	**6.8 (6.7–7.0)**	**44.7 (43.3–46.1)**	**9.9 (9.1–10.7)**

Abbreviation: CI = confidence interval.

* Defined as a "yes" response to the questions "Have you ever been told by a doctor or other health professional that you had asthma?" and "Do you still have asthma?"

† Survey respondents who answered "yes" to the question "Did you have a job or business at any time in the past 12 months?"

§ Defined as a "yes" response to the question "During the past 12 months, have you had an episode of asthma or an asthma attack?"

¶ Defined as a "yes" response to the question "During the past 12 months, have you had to visit an emergency room or urgent care center because of asthma?"

** Industry that employed sample adults were working in during the week prior to their interview. ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2014/srvydesc.pdf.

†† Weighted to provide national estimates.

§§ Estimates suppressed because relative standard error for the estimate was ≥30%.

TABLE 3. Current asthma* prevalence and proportion of adults working at any time in the past 12 months† with current asthma who had at least one asthma attack§ or emergency department visit for asthma¶ in the past 12 months (annual average), by occupation — National Health Interview Survey, 2011–2016**

Occupation	Workers (x 1,000)††	Current asthma		Proportion with current asthma and ≥1 asthma attack in past 12 months	Proportion with current asthma and ≥1 asthma ED visit in past 12 months
		No. (x 1,000)††	% (95%CI)	% (95%CI)	% (95%CI)
Health care support	3,754	331	8.8 (7.6–10.0)	45.5 (38.4–52.6)	13.5 (9.1–18.0)
Nursing, psychiatric, and home health aides	2,211	192	8.7 (7.1–10.2)	45.0 (35.9–54.2)	16.0 (9.7–22.3)
Occupational and physical therapist assistants and aides	107	—§§	—	—	—
Other health care support occupations	1,436	135	9.4 (7.3–11.5)	46.1 (35.2–57.1)	—
Personal care and service	5,666	488	8.6 (7.5–9.7)	44.6 (38.8–50.5)	17.4 (12.9–21.8)
Supervisors, personal care and service workers	167	14	8.1 (3.3–12.9)	—	—
Animal care and service workers	285	26	9.0 (4.0–14.1)	—	—
Entertainment attendants and related workers	310	—	—	—	—
Funeral service workers	43	—	—	—	—
Personal appearance workers	1,168	48	4.1 (2.6–5.6)	46.0 (28.1–63.8)	25.0 (10.3–39.7)
Transportation, tourism, and lodging attendants	155	—	—	—	—
Other personal care and service workers	3,539	364	10.3 (8.8–11.7)	44.8 (38.2–51.4)	16.2 (11.1–21.3)
Health care practitioners and technical	8,752	754	8.6 (7.8–9.5)	49.7 (44.7–54.8)	8.9 (6.1–11.7)
Health diagnosing and treating practitioners	5,991	534	8.9 (7.9–10.0)	49.4 (43.5–55.4)	8.6 (5.3–11.8)
Health technologists and technicians	2,651	209	7.9 (6.4–9.3)	48.8 (39.1–58.5)	8.6 (3.8–13.4)
Other health care practitioners and technical	110	—	—	—	—
Education, training, and library	10,233	867	8.5 (7.7–9.3)	51.5 (46.9–56.2)	8.8 (6.0–11.6)
Postsecondary teachers	1,623	113	6.9 (5.4–8.5)	38.1 (27.7–48.5)	—
Primary, secondary, and special education school teachers	6,046	525	8.7 (7.6–9.8)	51.7 (45.7–57.7)	8.5 (4.9–12.2)
Other teachers and instructors	1,078	82	7.7 (5.3–10.1)	48.3 (32.6–64.0)	—
Librarians, curators, and archivists	324	—	—	—	—
Other education, training, and library occupations	1,162	124	10.7 (8.0–13.3)	64.0 (51.7–76.4)	—
Arts, design, entertainment, sports, and media	3,408	273	8.0 (6.7–9.3)	51.0 (41.7–60.3)	—
Art and design workers	1,242	108	8.7 (6.3–11.1)	52.0 (36.9–67.0)	—
Entertainers and performers, sports and related workers	794	64	8.0 (5.0–11.0)	—	—
Media and communication workers	966	77	8.0 (5.7–10.3)	57.2 (42.5–71.9)	—
Media and communication equipment workers	406	25	6.1 (2.9–9.3)	62.8 (35.7–89.8)	—
Office and administrative support	19,777	1,588	8.0 (7.5–8.6)	44.8 (41.2–48.5)	8.6 (6.8–10.5)
Supervisors, office and administrative support workers	1,256	112	8.9 (6.7–11.2)	38.3 (25.9–50.8)	—
Communications equipment operators	88	—	—	—	—
Financial clerks	2,926	199	6.8 (5.6–8.0)	41.1 (30.7–51.5)	6.1 (2.6–9.5)
Information and record clerks	5,427	479	8.8 (7.7–10.0)	41.6 (35.3–47.9)	8.6 (5.3–11.9)
Material recording, scheduling, dispatching, and distributing workers	3,993	282	7.1 (5.8–8.4)	44.6 (33.9–55.2)	6.8 (3.2–10.3)
Secretaries and administrative assistants	2,907	209	7.2 (5.9–8.5)	46.9 (37.7–56.1)	11.9 (4.9–18.9)
Other office and administrative support workers	3,181	281	8.9 (7.6–10.2)	54.8 (47.6–62.1)	11.4 (6.5–16.3)
Food preparation and serving related	8,771	668	7.7 (6.7–8.6)	40.2 (34.2–46.1)	10.7 (7.2–14.3)
Supervisors, food preparation, and serving workers	951	78	8.3 (5.3–11.2)	52.8 (35.0–70.7)	—
Cooks and food preparation workers	3,317	232	7.0 (5.7–8.3)	41.2 (32.1–50.4)	12.7 (6.3–19.2)
Food and beverage serving working	3,617	292	8.2 (6.7–9.6)	38.1 (29.3–46.9)	10.4 (5.3–15.6)
Other food preparation and serving related workers	887	65	7.4 (5.1–9.7)	30.4 (15.1–45.7)	—
Community and social services	2,862	217	7.6 (6.5–8.8)	46.0 (37.5–54.4)	6.3 (2.8–9.7)
Counselors, social workers, and other community and social service specialists	2,199	173	7.9 (6.6–9.2)	43.0 (34.4–51.6)	7.4 (3.1–11.7)
Religious workers	663	44	6.7 (4.2–9.1)	57.5 (38.0–77.1)	—
Business and financial operations	7,710	588	7.6 (6.7–8.5)	41.0 (34.9–47.1)	9.5 (5.9–13.0)
Business operations specialists	4,162	319	7.7 (6.5–8.8)	37.9 (30.1–45.7)	8.8 (4.2–13.3)
Financial specialists	3,548	269	7.6 (6.2–8.9)	44.8 (35.8–53.7)	10.3 (4.9–15.7)

See table footnotes on page 384.

TABLE 3. (*Continued*) Current asthma* prevalence and proportion of adults working at any time in the past 12 months† with current asthma who had at least one asthma attack§ or emergency department visit for asthma¶ in the past 12 months (annual average), by occupation — National Health Interview Survey, 2011–2016**

Occupation	Workers (x 1,000)††	Current asthma		Proportion with current asthma and ≥1 asthma attack in past 12 months	Proportion with current asthma and ≥1 asthma ED visit in past 12 months
		No. (x 1,000)††	% (95%CI)	% (95%CI)	% (95%CI)
Legal	1,791	136	7.6 (5.8–9.4)	38.6 (27.1–50.1)	—
Lawyers, judges, and related workers	1,109	97	8.7 (6.2–11.3)	34.6 (20.7–48.5)	—
Legal support workers	682	40	5.8 (3.6–8.1)	48.3 (29.1–67.5)	—
Sales and related	16,266	1,152	7.1 (6.5–7.7)	42.9 (38.6–47.2)	12.4 (9.6–15.3)
Supervisors, sales workers	3,985	234	5.9 (4.9–6.9)	43.7 (34.6–52.8)	—
Retail sales workers	7,364	644	8.8 (7.8–9.7)	44.1 (38.4–49.9)	15.4 (11.2–19.6)
Sales representatives, services	1,911	121	6.3 (4.6–8.1)	34.2 (21.6–46.7)	—
Sales representatives, wholesale and manufacturing	1,392	61	4.4 (2.9–5.8)	41.0 (25.3–56.6)	—
Other sales and related workers	1,614	92	5.7 (4.1–7.3)	45.3 (31.4–59.3)	—
Protective service	3,272	232	7.1 (5.7–8.5)	40.4 (30.3–50.4)	—
First–line supervisors/managers, protective service workers	211	—	—	—	—
Firefighting and prevention workers	347	18	5.1 (2.2–8.0)	—	—
Law enforcement workers	1,306	105	8.1 (5.3–10.9)	39.1 (22.2–55.9)	—
Other protective service workers	1,408	95	6.8 (5.0–8.6)	40.1 (26.8–53.4)	—
Life, physical, and social science	1,668	110	6.6 (4.7–8.5)	41.5 (28.0–54.9)	—
Life scientists	348	24	6.9 (3.0–10.8)	35.7 (16.5–54.8)	—
Physical scientists	541	28	5.2 (2.8–7.7)	47.6 (25.1–70.1)	—
Social scientists and related workers	414	—	—	—	—
Life, physical, and social science technicians	365	20	5.4 (2.8–8.1)	—	—
Management	15,259	956	6.3 (5.7–6.8)	46.9 (42.0–51.7)	6.9 (4.4–9.4)
Chief executives; general and operations managers; legislators	2,172	138	6.3 (5.0–7.7)	36.3 (24.6–48.1)	—
Advertising, marketing, promotions, public relations, and sales managers	1,068	61	5.7 (3.8–7.5)	49.8(33.8–65.8)	—
Operations specialties managers	2,911	171	5.9 (4.7–7.1)	38.8 (28.1–49.4)	—
Other management occupations	9,108	588	6.5 (5.7–7.2)	51.4 (45.4–57.3)	7.3 (3.8–10.7)
Architecture and engineering	3,301	175	5.3 (4.2–6.4)	38.4 (27.9–49.0)	—
Architects, surveyors, and cartographers	291	—	—	—	—
Engineers	2,272	111	4.9 (3.7–6.1)	39.9 (27.1–52.7)	—
Drafters, engineering, and mapping technicians	738	44	5.9 (3.6–8.2)	33.6 (13.3–53.9)	—
Computer and mathematical	5,021	290	5.8 (4.8–6.8)	46.3 (38.1–54.5)	—
Computer specialists	4,774	276	5.8 (4.8–6.8)	45.9 (37.4–54.3)	—
Mathematical science occupations	247	—	—	—	—
Building and grounds cleaning and maintenance	6,518	364	5.6 (4.8–6.4)	51.0 (43.9–58.1)	15.1 (10.1–20.1)
Supervisors, building and grounds cleaning and maintenance workers	510	30	5.8 (2.6–9.0)	55.5 (30.8–80.1)	—
Building cleaning and pest control workers	4,552	307	6.8 (5.8–7.8)	51.7 (43.9–59.5)	16.7 (10.9–22.5)
Grounds maintenance workers	1,456	28	1.9 (1.1–2.7)	38.9 (16.1–61.8)	—
Installation, maintenance, and repair	5,513	312	5.7 (4.7–6.7)	39.1 (30.2–48.0)	—
Supervisors of installation, maintenance, and repair workers	315	36	11.5 (5.9–17.1)	—	—
Electrical and electronic equipment mechanics, installers, and repairers	681	33	4.8 (2.8–6.9)	—	—
Vehicle and mobile equipment mechanics, installers, and repairers	2,076	100	4.8 (3.3–6.4)	28.7 (15.4–42.0)	—
Other installation, maintenance, and repair occupations	2,441	143	5.9 (4.3–7.4)	46.7 (33.8–59.7)	—
Farming, fishing, and forestry	1,278	68	5.4 (3.6–7.1)	43.8 (26.4–61.2)	—
Supervisors, farming, fishing, and forestry workers	59	—	—	—	—
Agricultural workers	1,084	67	6.2 (4.2–8.2)	43.5 (25.8–61.1)	—
Fishing and hunting workers	45	—	—	—	—
Forest, conservation, and logging workers	90	—	—	—	—

See table footnotes on page 384.

TABLE 3. (*Continued*) Current asthma* prevalence and proportion of adults working at any time in the past 12 months† with current asthma who had at least one asthma attack§ or emergency department visit for asthma¶ in the past 12 months (annual average), by occupation — National Health Interview Survey, 2011–2016**

Occupation	Workers (x 1,000)††	Current asthma		Proportion with current asthma and ≥1 asthma attack in past 12 months	Proportion with current asthma and ≥1 asthma ED visit in past 12 months
		No. (x 1,000)††	% (95%CI)	% (95%CI)	% (95%CI)
Transportation and material moving	9,240	494	5.4 (4.7–6.1)	49.3 (42.8–55.8)	11.6 (8.3–14.9)
Supervisors, transportation and material moving workers	171	—	—	—	—
Air transportation workers	236	17	7.0 (3.2–10.8)	56.7 (29.7–83.7)	—
Motor vehicle operators	4,390	211	4.8 (4.0–5.7)	45.1 (36.8–53.5)	15.5 (9.5–21.5)
Rail transportation workers	100	—	—	—	—
Water transportation workers	60	—	—	—	—
Other transportation workers	327	—	—	—	—
Material moving workers	3,957	226	5.7 (4.6–6.9)	48.9 (38.4–59.3)	9.4 (5.1–13.6)
Production	9,490	484	5.1 (4.5–5.8)	36.3 (30.6–42.0)	10.2 (6.9–13.5)
Supervisors, production workers	821	55	6.7 (3.9–9.4)	39.5 (19.0–60.1)	—
Assemblers and fabricators	1,409	71	5.0 (3.4–6.7)	37.9 (20.4–55.5)	—
Food processing workers	776	43	5.6 (3.4–7.7)	32.7 (15.0–50.3)	—
Metal workers and plastic workers	1,938	115	5.9 (4.2–7.7)	30.2 (17.5–42.9)	—
Printing workers	288	—	—	—	—
Textile, apparel, and furnishings workers	682	26	3.9 (1.8–5.9)	37.7 (15.7–59.6)	—
Woodworkers	155	—	—	—	—
Plant and system operators	274	—	—	—	—
Other production occupations	3,148	132	4.2 (3.3–5.1)	40.8 (30.0–51.6)	—
Construction and extraction	8,139	324	4.0 (3.4–4.6)	37.5 (30.3–44.8)	8.2 (4.6–11.7)
Supervisors, construction and extraction workers	649	26	4.0 (1.9–6.1)	—	—
Construction trades workers	6,789	264	3.9 (3.2–4.6)	35.4 (27.7–43.0)	8.8 (4.7–12.9)
Helpers, construction trades	59	—	—	—	—
Other construction and related workers	402	—	—	—	—
Extraction workers	240	—	—	—	—
Military	367	—	—	—	—
Refused, not ascertained, don't know	2,653	92	3.5 (2.5–4.5)	50.1 (36.2–64.1)	—
Total	**160,672**	**10,957**	**6.8 (6.7–7.0)**	**44.7 (43.3–46.1)**	**9.9 (9.1–10.7)**

Abbreviation: CI = confidence interval.

* Defined as a "yes" response to the questions "Have you ever been told by a doctor or other health professional that you had asthma?" and "Do you still have asthma?"

† Survey respondents who answered "yes" to the question "Did you have a job or business at any time in the past 12 months?"

§ Defined as a "yes" response to the question "During the past 12 months, have you had an episode of asthma or an asthma attack?"

¶ Defined as a "yes" response to the question "During the past 12 months, have you had to visit an emergency room or urgent care center because of asthma?"

** Occupation that employed sample adults had during the week prior to their interview. ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2014/srvydesc.pdf.

†† Weighted to provide national estimates.

§§ Estimates suppressed because relative standard error for the estimate was ≥30%.

By detailed occupation subgroup, the highest prevalence of current asthma (10.7%) and asthma attack in the past 12 months (64.0%) was among workers in other education, training, and library occupations†† (Table 3). Prevalence of asthma-related ED visits was highest among personal appearance workers§§ (25.0%). The highest number of workers with asthma attacks was among those working in other management occupations¶¶ (302,000), and the highest number of workers with asthma-related ED visits was among retail sales workers (99,000).

†† Audio-visual and multimedia collections specialists; farm and home management advisors; instructional coordinators; teacher assistants; miscellaneous education, training, and library workers (25-9000 Other Education, Training, and Library Occupations). https://www.bls.gov/soc/2010/2010_major_groups.htm#25-0000.

§§ Barbers; hairdressers, hairstylists and cosmetologists; makeup artists, theatrical and performance; manicurists and pedicurists; shampooers; skin care specialists (39-5000 Personal Appearance Workers). https://www.bls.gov/soc/2010/2010_major_groups.htm#39-0000.

¶¶ Farmers, ranchers, and other agricultural managers; construction managers; education administrators; architectural and engineering managers; food service managers; funeral service managers; gaming managers; lodging managers; medical and health services managers; natural sciences managers; postmasters and mail superintendents; property, real estate, and community association managers; social and community service managers; emergency management directors (11-9000 Other Management Occupations). https://www.bls.gov/soc/2010/2010_major_groups.htm#11-0000.

Summary

What is already known about this topic?

In 2010, an estimated 8.2% of U.S. adults had current asthma; among them, 49.1% reported at least one asthma attack in the past year. Up to 51% of adult asthma might be related to work and could therefore potentially be prevented.

What is added by this report?

During 2011–2016, among an estimated 160.7 million working adults, 6.8% had current asthma. Among those with asthma, 44.7% experienced an asthma attack, and 9.9% had an asthma-related emergency department visit in the previous year. The current asthma prevalence was highest among workers employed in the health care and social assistance industry (8.8%) and in health care support occupations (8.8%).

What are the implications for public health practice?

This information might assist physicians to identify workers who should be evaluated for possible work-related asthma and could help public health officials identify workplaces where detailed investigations for prevention and control might be appropriate. Guidelines promoting effective management of work-related asthma are available.

Discussion

This report provides industry- and occupation-specific prevalence estimates of current asthma, and among those with current asthma, the prevalence of at least one asthma attack and at least one asthma-related ED visit in the past year. The numbers of workers reporting asthma attacks and asthma-related ED visits in specific industries and occupations correlate with the numbers of workers and current asthma prevalence in each group. The increased prevalence of current asthma, asthma attacks, and asthma-related ED visits in certain industries and occupations might indicate increased risks for these health outcomes associated with workplace exposures. The highest prevalence of current asthma was among workers in the health care and social assistance industry and in health care support occupations. New-onset work-related asthma in these workers has been associated with exposure to cleaning and disinfecting products, powdered latex gloves, and aerosolized medications (*4*). Nearly two thirds of the workers with asthma in the wood products and in the plastics and rubber products manufacturing industries had at least one asthma attack in the past year. Workers in these industries are at increased risk for work-related asthma (*5*,*6*), and the high proportion of workers with a history of an asthma attack in this report suggests a high risk for work-related exacerbation of asthma. Education, training, and library workers are also at risk for work-related asthma and adverse health outcomes (*7*).

NHIS did not collect data on severity of asthma exacerbations and asthma work-relatedness. The subset of patients who experience severe asthma exacerbations have an accelerated decline in lung function, greater health care utilization, and a lower quality of life (*3*,*8*). Based on the estimate that approximately 51% of adult asthma might be caused or made worse by work (*9*), as many as 5.6 million workers might have asthma or asthma outcomes related to work that could be prevented. Physicians should consider work-related asthma in all workers with new-onset or worsening asthma (*2*,*3*).

Workplace conditions and exposures associated with asthma include irritant chemicals, dusts, secondhand tobacco smoke, allergens and sensitizers, emotional stress, worksite temperature, and physical exertion (*3*). A list of asthmagens causing work-related asthma by sensitization or acute irritant-induced asthma is available (http://www.aoecdata.org/ExpCodeLookup.aspx). Identification of potential asthma-related agents in the workplace can be facilitated by obtaining safety data sheets.*** Guidelines intended to promote effective management of work-related asthma are available (*2*,*3*). The preferred primary strategy to prevent work-related asthma and reduce signs, symptoms, and progression of disease is exposure control (i.e., elimination or substitution of hazardous products, engineering controls, and respiratory protection). However, if these approaches are unsuccessful, removal of the worker from exposure might sometimes be necessary for management of work-related asthma (*2*,*3*,*10*).

The findings in this report are subject to at least four limitations. First, information on asthma, asthma attacks, and asthma-related ED visits was self-reported and not validated by medical records. It is likely that some respondents had misdiagnosed or undiagnosed asthma. Second, no temporal information on asthma onset and exacerbations was available; thus, it was not possible to determine asthma association with work. Third, only workers employed at some time in the past 12 months were included in this study. Those with severe asthma might have left employment in industries and occupations with workplace exposures that exacerbate their asthma; thus, industry and occupation in this report might not accurately identify workers' industry and occupation where exposures occur. Finally, small sample sizes for some groups resulted in unreliable estimates.

These findings might assist physicians to identify workers who should be evaluated for possible work-related asthma in industries and occupations with a high prevalence of asthma, asthma attacks, and asthma-related ED visits and could help public health officials identify workplaces where detailed investigations for prevention and control might be appropriate. Continued surveillance is important to assess asthma prevalence and trends by respondents' industry and occupation.

*** https://www.osha.gov/Publications/HazComm_QuickCard_SafetyData.html.

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Conflict of Interest

No conflicts of interest were reported.

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Phosphine Exposure Among Emergency Responders — Amarillo, Texas, January 2017

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Phosphine is a highly toxic gas that forms when aluminum phosphide, a restricted-use pesticide* typically used in agricultural settings, reacts with water. Acute exposure can lead to a wide range of respiratory, cardiovascular, and gastrointestinal symptoms, and can be fatal (*1*). On January 2, 2017, the Texas Department of State Health Services (DSHS) was notified by the Texas Panhandle Poison Center of an acute phosphine exposure incident in Amarillo, Texas. DSHS investigated potential occupational phosphine exposures among the 51 on-scene emergency responders; 40 (78.4%) did not use respiratory protection during response operations. Fifteen (37.5%) of these 40 responders received medical care for symptoms or as a precaution after the incident, and seven (17.5%) reported new or worsening symptoms consistent with phosphine exposure within 24 hours of the incident. Emergency response organizations should ensure that appropriate personal protective equipment (PPE) is used during all incidents when an unknown hazardous substance is suspected. Additional evaluation is needed to identify targeted interventions that increase emergency responder PPE use during this type of incident.

Investigation and Response

At approximately 5:00 a.m. on January 2, 2017, emergency responders were dispatched to a single-family residence following a 9-1-1 call reporting shortness of breath, loss of consciousness, and other symptoms among occupants. These health effects were initially thought to be the result of carbon monoxide exposure; however, air monitoring detected no carbon monoxide. Emergency responders discovered that a restricted-use pesticide containing aluminum phosphide had been applied outside the residence several days before the 9-1-1 call. It was determined that phosphine had been released when the pesticide reacted with water, first from ambient humidity, and then when attempts were made to wash the pesticide away on January 1, 2017.

Because a hazardous substance was suspected, the City of Amarillo dispatched a hazardous materials (HAZMAT) team composed of fire department personnel and established a secure perimeter around the home. Persons found inside were assisted out of the residence, given emergency medical care, and transported to a nearby hospital. Domestic animals found on-scene were decontaminated by dry brushing and taken to a local animal welfare facility. The local health authority issued a health alert to inform medical care providers.

Later on January 2, the City of Amarillo requested a toxicologic consultation from DSHS related to the incident. Based on incident response activities described during the consultation, it was determined that emergency responders might have been exposed to phosphine at the scene. Therefore, DSHS investigated potential occupational phosphine exposures and associated health effects among all City of Amarillo personnel who participated in the emergency response.

DSHS reviewed Texas Poison Control Network call records related to the event, and then designed a standardized health questionnaire based on the Agency for Toxic Substances and Disease Registry's (ATSDR's) Assessment of Chemical Exposures toolkit to interview potentially exposed emergency responders (*2*). Data collected included demographics, work history, role in the response, PPE use, potential exposure to phosphine and related acute health effects, emergency response training, and medical care received. Local health department personnel administered the questionnaire for DSHS via in-person and telephone interviews from January 23 through February 3, 2017. Data were analyzed by DSHS; data that could potentially identify an individual were suppressed if counts were fewer than five.

Fifty-one emergency responders participated on-scene in the response. Air monitoring data were limited, so all were considered potentially exposed to phosphine and contacted for a follow-up interview. All 51 (100%) responders participated, including fire, police, animal welfare, and emergency medical services personnel. The median emergency responder age was 31 years (range = 20–54 years) and the median length of time in their current job was 5 years (range = 2 months–30 years).

Eleven responders (21.6%), including seven firefighters and HAZMAT team members, reported use of respiratory protection while on-scene; none of these persons reported symptoms within 24 hours or sought medical care following the incident (Table 1). Fifteen (37.5%) of the 40 emergency responders who did not use respiratory protection received medical care for symptoms or as a precaution after the incident. Seven (17.5%) of these 40 reported new or worsening symptoms within 24 hours of the response. Symptoms included irritability, ocular pain or burning, headache, nausea, drowsiness, dizziness, burning of nose or throat, abdominal cramps, diarrhea, generalized weakness, trembling legs or hands, and trouble walking.

* Pesticide registration and classification procedures, 40 C.F.R. Sect. 152.160-152.175 (2018).

TABLE 1. Characteristics of emergency responders potentially exposed during a phosphine release event (n = 51) — Amarillo, Texas, 2017

Characteristic	No.* (%)
Role during response operations†	
Provide medical care	15 (29.4)
Animal control	9 (17.6)
Rescue victims/First response	9 (17.6)
HAZMAT team	8 (15.7)
Security/Guard perimeter	5 (9.8)
Supervise	5 (9.8)
Operations and logistics	<5 (—)
Other	<5 (—)
Unknown	<5 (—)
Initial information received before on-scene arrival†	
Medical emergency	38 (74.5)
Possible carbon monoxide release	11 (21.6)
Unknown chemical hazard	10 (19.6)
HAZMAT	7 (13.7)
Phosphine release	<5 (—)
Other	<5 (—)
Unknown/Missing	<5 (—)
Hours worked at incident site§	
<1	15 (30.0)
1–1.9	17 (34.0)
2–2.9	7 (14.0)
≥3	11 (22.0)
Respiratory protection used	
Yes	11 (21.6)
No	40 (78.4)
Symptoms of illness within 24 hours of the incident¶	
Yes	7 (13.7)
No or not sure	44 (86.3)
Medical care sought	
Yes	15 (29.4)
No	36 (70.6)

Abbreviation: HAZMAT = hazardous materials.
* Counts <5 suppressed to protect confidentiality.
† Categories are not mutually exclusive.
§ n = 50.
¶ Fifteen (37.5%) of the 40 emergency responders who did not use respiratory protection received medical care for symptoms or as a precaution after the incident. Seven (17.5%) of these 40 reported new or worsening symptoms within 24 hours of the response. None of the 11 who used respiratory protection reported symptoms or having received medical care.

Among the 40 responders who did not use respiratory protection, 14 (35%) provided the following nonmutually exclusive reasons: did not know it was needed or were not told to use it (five); rescuing victims was more important (four); did not know the contaminant was present (four); was not required for the work performed (two); and did not have equipment (one).

Thirty-seven (72.5%) of the 51 responders stated that their agency had plans or standard operating procedures for responding to situations where hazardous materials are present. Forty (78.4%) reported receiving at least one emergency response training† before the incident (Table 2), including 29 (72.5%) of the 40 responders who did not use respiratory protection.

† Responders might not have been required to take trainings listed as a condition of employment.

TABLE 2. Emergency response trainings received by responders who were potentially exposed during a phosphine release event (n = 51) — Amarillo, Texas, 2017

Training	No.* (%)
Any emergency response training†	40 (78.4)
First responder awareness	27 (52.9)
Hazardous materials technicians, 24 hr.	26 (51.0)
First responder operations, 8 hr.	15 (29.4)
Other§	14 (27.5)
HAZWOPER, 24 hr.	5 (9.8)
HAZWOPER, 40 hr.	<5 (—)
No emergency response training¶	11 (21.6)

Abbreviation: HAZWOPER = hazardous waste operations and emergency response.
* Counts <5 suppressed to protect confidentiality.
† Categories are not mutually exclusive.
§ Includes animal control, animal cruelty training (levels 1, 2, 3); National Incident Management Incident Command System 100, 200, 300, 400, 700 and 800; and police academy training.
¶ Responders might not have been required to take trainings listed as a condition of employment.

Discussion

CDC and other agencies have developed protocols and tools to facilitate implementation of best practices for responding to incidents involving unknown chemical hazards, and their use has been recommended following similar incidents in the past (*3*,*4*). Federal regulations require the use of appropriate respiratory protection in emergency responses involving suspected hazardous substances.§ DSHS recommends implementation of these recommendations and has worked with the National Institute for Occupational Safety and Health Emergency Preparedness and Response Office to develop and disseminate educational materials targeted to emergency responders and emergency response organizations to highlight the importance of using appropriate respiratory protection.

The 51 emergency responders involved in this incident were faced with limited information about the hazards present, combined with the need to act quickly to rescue victims. Many did not use recommended respiratory protection. These issues exemplify challenges faced by emergency responders who often confront unknown hazards and, given the need to save lives or secure the scene, might feel they do not have time to identify, obtain, and don recommended PPE (*3*,*6*). They also might perceive that PPE would physically restrict their ability to perform required tasks (*6*).

Studies of other incidents involving the known or suspected release of hazardous substances have similarly found low prevalences of respiratory PPE use among emergency responders, especially police and emergency medical services. For example, one investigation found that among 92 emergency personnel who responded to an unintentional vinyl chloride release, only 20 (21.7%) reported using indicated respiratory protection during the response (*3*). Multiple studies have found that the

§ Worker protection, 40 C.F.R. Sect. 311.1 and 311.2 (2018).

Summary

What is already known on this topic?

To prevent exposure to harmful chemical substances among emergency responders, use of respiratory and other personal protective equipment (PPE) is recommended during incident responses when release of an unknown hazardous substance is suspected. Past studies have found low prevalences of respiratory protection use during hazardous substance release incidents.

What is added by this report?

Forty (78.4%) of 51 emergency personnel responding to an acute phosphine exposure incident in Texas in January 2017 did not use respiratory protection, including 15 (37.5%) who received medical care after the incident and seven (17.5%) who reported new or worsening symptoms consistent with phosphine exposure within 24 hours of the incident. The majority had received standard emergency response training and knew of agency standard operating procedures for responding to incidents involving hazardous substances.

What are the implications for public health practice?

Although emergency responder risk of exposure during incidents involving unknown hazardous substances is well documented, methods for improving compliance with existing recommendations and regulations for respiratory protection use are not well understood. Additional evaluation is needed to identify targeted interventions that effectively increase appropriate PPE use among emergency responders during incidents involving such unknown hazards.

prevalence of appropriate respiratory protection was low among emergency responders to the World Trade Center collapse (*7*). A recent analysis of ATSDR surveillance data found that, among 1,275 emergency personnel with known PPE status who were injured or became ill during acute hazardous substance release incident responses during 2002–2012, only 382 (30.0%) wore some type of respiratory protection (*8*). Respiratory protection prevalence was 45.8% among injured firefighters, compared with 1.4% among police and 2.3% among emergency medical services personnel. Firefighters' injuries were more likely to involve trauma or burns than were those sustained by other types of responders. Because PPE use among emergency personnel who were not injured or ill was not collected, it was not possible to assess the effectiveness of PPE in preventing injuries and illness.

The findings in this report are subject to at least two limitations. First, information bias is possible because exposure and symptom status were identified by self-report. However, no data were available to estimate individual phosphine exposure. Personal air monitoring was not conducted, and air samples were not collected inside the residence before remediation. Second, not all symptomatic persons sought medical treatment, so medical records were insufficient to assess health outcomes. Therefore, self-report was the most comprehensive source of information on exposure and health outcomes.

This incident demonstrates that, although important, standard emergency responder trainings alone might not ensure correct PPE use during this type of incident response. Studies among health care, farm, construction, and manufacturing workers have found that individual behavioral interventions (e.g., training and education) alone do not significantly improve respiratory protection use (*9*). Some studies have found that interventions targeting social and organizational factors, such as safety climate, do positively impact PPE use (*6*). However, few studies of PPE-related behavioral interventions have been conducted among emergency responders, so methods for improving compliance with existing PPE guidance and regulations among responders are not well understood. Additional evaluation is needed to identify targeted individual and organizational interventions that effectively increase appropriate PPE use among emergency responders during incidents involving unknown hazards.

Acknowledgments

National Institute for Occupational Safety and Health, CDC.

Conflict of Interest

No conflicts of interest were reported.

[1]Texas Department of State Health Services; [2]Emergency Preparedness and Response Office, National Institute for Occupational Safety and Health, CDC; [3]World Trade Center Health Program, National Institute for Occupational Safety and Health, CDC.

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State Medicaid Coverage for Tobacco Cessation Treatments and Barriers to Accessing Treatments — United States, 2015–2017

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Cigarette smoking prevalence among Medicaid enrollees (25.3%) is approximately twice that of privately insured Americans (11.8%), placing Medicaid enrollees at increased risk for smoking-related disease and death (*1*). Medicaid spends approximately $39 billion annually on treating smoking-related diseases (*2*). Individual, group, and telephone counseling and seven Food and Drug Administration (FDA)–approved medications* are effective in helping tobacco users quit (*3*). Although state Medicaid coverage of tobacco cessation treatments improved during 2014–2015, coverage was still limited in most states (*4*). To monitor recent changes in state Medicaid cessation coverage for traditional (i.e., nonexpansion) Medicaid enrollees, the American Lung Association collected data on coverage of a total of nine cessation treatments: individual counseling, group counseling, and seven FDA-approved cessation medications† in state Medicaid programs during July 1, 2015–June 30, 2017. The American Lung Association also collected data on seven barriers to accessing covered treatments, such as copayments and prior authorization. As of June 30, 2017, 10 states covered all nine of these treatments for all enrollees, up from nine states as of June 30, 2015; of these 10 states, Missouri was the only state to have removed all seven barriers to accessing these cessation treatments. State Medicaid programs that cover all evidence-based cessation treatments, remove barriers to accessing these treatments, and promote covered treatments to Medicaid enrollees and health care providers would be expected to reduce smoking, smoking-related disease, and smoking-attributable federal and state health care expenditures (*5*–*7*).

During July 2015–June 2017, the American Lung Association compiled data on state Medicaid tobacco cessation coverage from state Medicaid and Medicaid managed care plan member and provider websites and handbooks, policy manuals, plan formularies and preferred drug lists, Medicaid state plan amendments, and relevant regulations and laws.§ Analysts searched for mentions of the nine cessation treatments using search functions on state Medicaid websites and other relevant state-sponsored websites and the Google search engine. The American Lung Association contacted personnel from state Medicaid agencies, state health departments, or other state government agencies to give them the opportunity to verify the information collected and to retrieve missing documents and reconcile discrepancies.

As of June 30, 2017, 10 states (California, Connecticut, Indiana, Maine, Massachusetts, Minnesota, Missouri, New York, Ohio, and Vermont) covered all nine cessation treatments for all Medicaid enrollees, an increase from nine states in June 2015 (Table 1) (Table 2). Three states (California, Missouri, and New York) achieved this level of coverage during the study period. Conversely, North Dakota and Pennsylvania, which covered all nine cessation treatments in June 2015, no longer did so in June 2017.¶ As of June 30, 2017, nine of the 10 states that covered all cessation treatments had barriers in place for some treatments (Table 3); the remaining state, Missouri, has removed all barriers examined in this study. Two additional states (Kentucky and South Carolina) achieved comprehensive coverage effective July 1, 2017, after conclusion of the study period; Kentucky also removed all barriers to accessing the nine cessation treatments.**

As of June 30, 2017, all 50 states and the District of Columbia (DC) covered at least some cessation treatments for

* These medications include the nicotine patch, gum, lozenge, nasal spray, and inhaler and bupropion and varenicline.

† Telephone counseling is available free to callers to state quitlines (including Medicaid enrollees) in all 50 states and the District of Columbia through the national quitline portal 1-800-QUIT-NOW, and therefore is not captured by this report. In June 2011, the Centers for Medicare & Medicaid Services announced that it would offer a 50% federal administrative match to state Medicaid programs for the cost of state quitline counseling provided to Medicaid enrollees.

§ Information on state Medicaid cessation coverage compiled by the American Lung Association is available in the CDC State Activities Tracking and Evaluation (STATE) System, a database that contains tobacco-related epidemiologic and economic data and information on state tobacco-related legislation (https://www.cdc.gov/statesystem). Certain data presented in this report differ slightly from Medicaid cessation coverage data reported in the STATE System because of small differences in coding rules, categories, and reporting periods.

¶ These two states are no longer considered to provide comprehensive Medicaid cessation coverage because of a change in how cessation counseling benefits are administered in North Dakota and the addition of a new Medicaid managed care plan in Pennsylvania that did not provide comprehensive coverage.

** Kentucky achieved comprehensive Medicaid cessation coverage and removed barriers impeding Medicaid enrollees' access to cessation treatments by enacting a state law (Ky. Rev. Stat. Ann. Sect. 205) that also applied to private cessation insurance coverage. South Carolina achieved comprehensive Medicaid cessation coverage by issuing a Medicaid bulletin (https://www.scdhhs.gov/press-release/tobacco-cessation-coverage).

TABLE 1. Medicaid coverage for tobacco cessation counseling, by state — United States, 2015 and 2017*,†

State	Individual counseling		Group counseling	
	2015	2017	2015	2017
Alabama	P	P	No	No
Alaska	Yes	Yes	No	No
Arizona	P	P	No	No
Arkansas	Yes	Yes	No	No
California	V	Yes	V	Yes
Colorado	P	Yes	P	V
Connecticut	Yes	Yes	Yes	Yes
Delaware	Yes	Yes	No	No
District of Columbia	NA	Yes	NA	V
Florida	V	V	V	V
Georgia	Yes	Yes	No	No
Hawaii	V	Yes	V	V
Idaho	Yes	Yes	No	No
Illinois	No	No	No	No
Indiana	Yes	Yes	Yes	Yes
Iowa	Yes	Yes	No	V
Kansas	P	P	P	P
Kentucky	V	V	V	V
Louisiana	No	No	V	V
Maine	Yes	Yes	Yes	Yes
Maryland	Yes	Yes	V	V
Massachusetts	Yes	Yes	Yes	Yes
Michigan	Yes	Yes	V	V
Minnesota	Yes	Yes	Yes	Yes
Mississippi	V	V	No	V
Missouri	Yes	Yes	No	Yes
Montana	Yes	Yes	No	No
Nebraska	Yes	Yes	No	No
Nevada	Yes	V	No	V
New Hampshire	Yes	Yes	V	V
New Jersey	Yes	V	No	No
New Mexico	Yes	V	No	V
New York	Yes	Yes	Yes	Yes
North Carolina	Yes	Yes	No	No
North Dakota	Yes	No	Yes	No
Ohio	Yes	Yes	Yes	Yes
Oklahoma	Yes	Yes	No	No
Oregon	Yes	Yes	V	V
Pennsylvania	Yes	Yes	Yes	V
Rhode Island	Yes	Yes	V	V
South Carolina	V	V	V	V
South Dakota	P	P	No	No
Tennessee	No	P	No	No
Texas	V	V	V	V
Utah	P	Yes	P	P
Vermont	Yes	Yes	Yes	Yes
Virginia	V	V	V	V
Washington	V	V	No	No
West Virginia	No	Yes	V	No
Wisconsin	Yes	Yes	V	V
Wyoming	Yes	Yes	No	No
Total count				
Yes	31	33	10	10
No	4	3	22	19
V	9	10	15	20
P	6	5	3	2
NA	1	0	1	0

Abbreviations: NA = information not available; No = treatment not covered for any Medicaid enrollee; P = treatment covered for pregnant women only; V = coverage varies, with treatment covered for some, but not all, Medicaid enrollees; Yes = treatment covered for all Medicaid enrollees.

* Data as of June 30, 2015, and June 30, 2017.

† Because of differences in the methods and timing of data collection, some findings differ from findings on this topic reported in MMWR before 2014 (https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5941a4.htm).

all Medicaid enrollees, compared with 48 states in June 2015. As of June 30, 2017, 32 states covered all seven FDA-approved cessation medications for all enrollees, up from 30 states in June 2015 (Table 2). Thirty-three states covered individual counseling as of June 30, 2017, with 10 of these states covering group counseling as well, compared with 31 states and 10 states, respectively, as of June 2015 (Table 1).

During July 1, 2015–June 30, 2017, 13 states removed copayments for cessation treatments for at least some Medicaid enrollees, and the number of states that do not require copayments for any cessation treatment for any Medicaid enrollees increased from 16 to 27 states. As of June 30, 2017, the most common barriers were limits on duration (with 41 states reporting this barrier for at least certain populations or plans), prior authorization requirements (38 states), annual limits on quit attempts (34 states), and required copayments (24 states) (Table 3).

Discussion

Some progress occurred in state Medicaid coverage of proven tobacco cessation treatments during July 2015–June 2017, with the number of states covering all nine cessation treatments for all traditional (i.e., nonexpansion) Medicaid enrollees increasing from nine to 10 and the number of states covering all seven FDA-approved cessation medications increasing from 30 to 32. However, coverage still falls substantially short of the *Healthy People 2020* objective of comprehensive cessation coverage in all 50 states and DC.†† Moreover, as of June 2017, all but one state retained barriers that make it more difficult for Medicaid enrollees to access cessation treatments. Removing these barriers would be expected to increase access to and use of cessation treatments (*3*,*6*). Comprehensive Medicaid tobacco cessation coverage with minimal barriers can help more Medicaid enrollees quit smoking, resulting in improved health and potentially reducing smoking-attributable Medicaid expenditures (*5*–*7*).

†† https://www.healthypeople.gov/2020/topics-objectives/topic/tobacco-use/objectives.

TABLE 2. Medicaid coverage for tobacco cessation medications, by state — United States, 2015 and 2017*,†

	NRT patch		NRT gum		NRT lozenge		NRT nasal spray		NRT inhaler		Bupropion (Zyban)		Varenicline (Chantix)	
State	2015	2017	2015	2017	2015	2017	2015	2017	2015	2017	2015	2017	2015	2017
Alabama	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Alaska	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Arizona	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Arkansas	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes
California	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Colorado	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Connecticut	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Delaware	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District of Columbia	NA	Yes	NA	Yes	NA	Yes	NA	V	NA	V	NA	Yes	NA	Yes
Florida	Yes	V	Yes	V	Yes	V	No	No	No	No	Yes	Yes	Yes	Yes
Georgia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	V	Yes	V	Yes	Yes	Yes	V
Hawaii	Yes	Yes	Yes	Yes	V	V	V	V	V	V	V	Yes	V	Yes
Idaho	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Illinois	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Indiana	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Iowa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kansas	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kentucky	Yes	Yes	V	Yes	V	Yes	V	Yes	V	Yes	V	Yes	V	Yes
Louisiana	V	V	V	V	V	V	V	V	V	V	Yes	Yes	V	V
Maine	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Maryland	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Massachusetts	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Michigan	Yes	Yes	Yes	Yes	Yes	Yes	V	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Minnesota	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mississippi	Yes	Yes	Yes	Yes	Yes	Yes	V	Yes	V	Yes	Yes	Yes	Yes	Yes
Missouri	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Montana	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes
Nebraska	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nevada	Yes	V	Yes	V	Yes	V	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
New Hampshire	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
New Jersey	Yes	Yes	Yes	V	Yes	V	Yes	V	Yes	V	Yes	Yes	Yes	Yes
New Mexico	Yes	Yes	Yes	Yes	Yes	Yes	V	V	V	V	V	Yes	Yes	Yes
New York	Yes	Yes	Yes	Yes	V	Yes	V	Yes	V	Yes	Yes	Yes	Yes	Yes
North Carolina	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
North Dakota	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ohio	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oklahoma	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oregon	V	Yes	V	Yes	V	V	V	V	V	V	V	Yes	V	Yes
Pennsylvania	Yes	Yes	Yes	Yes	Yes	Yes	Yes	V	Yes	V	Yes	Yes	Yes	V
Rhode Island	Yes	Yes	Yes	Yes	Yes	V	Yes	No	Yes	No	Yes	Yes	Yes	Yes
South Carolina	Yes	Yes	Yes	Yes	V	V	V	V	V	V	V	Yes	V	V
South Dakota	P	No	P	No	P	No	No	No	No	No	Yes	Yes	Yes	Yes
Tennessee	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Texas	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Utah	V	V	V	V	V	V	V	V	V	V	Yes	Yes	Yes	Yes
Vermont	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Virginia	Yes	Yes	V	V	V	V	V	V	V	V	V	V	V	V
Washington	V	Yes	V	Yes	V	V	V	V	V	V	V	Yes	V	V
West Virginia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Wisconsin	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wyoming	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes
Total count														
Yes	45	46	43	44	38	38	32	33	33	34	43	50	42	45
No	0	1	0	1	2	2	6	6	6	5	0	0	1	0
V	4	4	6	6	9	11	12	12	11	12	7	1	7	6
P	1	0	1	0	1	0	0	0	0	0	0	0	0	0
NA	1	0	1	0	1	0	1	0	1	0	1	0	1	0

Abbreviations: NA = information not available; No = treatment not covered for any Medicaid enrollee; NRT = nicotine replacement therapy; P = treatment covered for pregnant women only; V = coverage varies, with treatment covered for some, but not all, Medicaid enrollees; Yes = treatment covered for all Medicaid enrollees.

* Data as of June 30, 2015, and June 30, 2017.

† Because of differences in the methods and timing of data collection, some findings differ from findings on this topic reported in MMWR before 2014 (https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5941a4.htm).

TABLE 3. Barriers to Medicaid coverage for tobacco cessation treatments, by state — United States, 2015 and 2017*,†,§

State	Copayments required		Prior authorization required		Counseling required for medications		Stepped-care therapy		Limits on duration		Annual limit on quit attempts		Lifetime limit on quit attempts	
	2015	2017	2015	2017	2015	2017	2015	2017	2015	2017	2015	2017	2015	2017
Alabama	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No
Alaska	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Arizona	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Arkansas	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No
California	No	No	V	V	No	No	V	No	V	V	V	V	No	No
Colorado	V	No	Yes	Yes	V	No	No	V	Yes	Yes	Yes	Yes	No	No
Connecticut	No	No	Yes	Yes	No	No	No	No	Yes	Yes	No	No	No	No
Delaware	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No
District of Columbia	NA	No	NA	V	NA	No	NA	No	NA	V	NA	V	NA	No
Florida	V	V	V	No	No	No	V	No	V	Yes	V	No	V	No
Georgia	No	No	Yes	V	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Hawaii	V	No	V	V	V	V	V	V	V	V	Yes	Yes	No	No
Idaho	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Illinois	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Indiana	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Iowa	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Kansas	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Kentucky	V	No	V	V	V	No	No	No	V	Yes	V	Yes	No	No
Louisiana	Yes	Yes	V	V	V	V	No	No	V	V	No	No	No	No
Maine	No	No	Yes	Yes	No	No	Yes	Yes	No	No	No	No	No	No
Maryland	V	No	V	Yes	V	No	V	Yes	V	Yes	V	Yes	No	No
Massachusetts	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes	Yes	No	No
Michigan	No	No	V	No	No	No	V	No	V	V	Yes	No	No	No
Minnesota	Yes	No	No	V	No	No	No	No	No	V	No	No	No	No
Mississippi	V	V	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No
Missouri	No	No	Yes	No	No	No	No	No	Yes	No	No	No	Yes	No
Montana	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Nebraska	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No
Nevada	Yes	No	Yes	Yes	No	No	No	V	Yes	Yes	Yes	Yes	No	No
New Hampshire	Yes	V	Yes	V	No	No	No	No	No	V	Yes	V	No	No
New Jersey	V	No	V	V	No	No	No	V	V	V	V	V	V	V
New Mexico	No	V	V	V	V	V	No	No	V	V	V	V	No	No
New York	V	V	V	No	No	No	No	No	Yes	No	Yes	No	No	No
North Carolina	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No	No	No
North Dakota	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No
Ohio	Yes	No	V	V	No	No	V	V	No	V	No	V	No	No
Oklahoma	Yes	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Oregon	No	No	V	V	V	V	No	V	V	V	V	V	No	No
Pennsylvania	Yes	V	V	V	No	No	No	No	Yes	Yes	No	No	No	No
Rhode Island	No	No	Yes	Yes	Yes	No	Yes	No	Yes	V	Yes	No	No	No
South Carolina	V	V	V	V	V	V	V	V	Yes	Yes	V	V	No	No
South Dakota	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Tennessee	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No
Texas	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No
Utah	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No
Vermont	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	No	No
Virginia	V	V	V	V	V	V	V	V	V	V	V	V	No	No
Washington	No	No	V	V	V	V	No	No	V	V	V	V	V	V
West Virginia	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	No
Wisconsin	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Wyoming	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No
Total count														
Yes	**24**	**16**	**23**	**22**	**10**	**9**	**11**	**11**	**26**	**27**	**26**	**24**	**1**	**0**
No	**16**	**27**	**11**	**13**	**30**	**35**	**31**	**32**	**12**	**10**	**14**	**17**	**46**	**49**
V	**10**	**8**	**16**	**16**	**10**	**7**	**8**	**8**	**12**	**14**	**10**	**10**	**3**	**2**
NA	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**
NA	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**

Abbreviations: NA = information not available; No = barrier does not apply to any Medicaid enrollee for any treatment; V = Varies, barrier applies to some, but not all, Medicaid enrollees for one or more treatments; Yes = barrier applies to all Medicaid enrollees for one or more treatments.

* Data as of June 30, 2015, and June 30, 2017.

† Because of differences in the methods and timing of data collection, some findings differ from findings on this topic reported in MMWR before 2014 (https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5941a4.htm).

The increase in the number of states covering all seven FDA-approved cessation medications might have resulted, in part, from a federal requirement that traditional state Medicaid programs cover these medications (*8*).[§§] State Medicaid programs can maximize the impact of this coverage by placing cessation medications on preferred drug lists, removing barriers to access, and adding notices of coverage to public plan documents. In 2015, 69.2% of adult Medicaid enrollees nationally who smoked reported wanting to quit, and 56.3% had made a quit attempt in the past year (*9*). However, only 34.5% of adult smokers on Medicaid used cessation counseling, medication, or both when trying to quit (with 8.0% using counseling and 32.2% using medication); 59.9% who had seen a health professional in the past year received advice to quit, and 5.9% succeeded in quitting (*9*). Comprehensive coverage of evidence-based cessation treatments could increase quit attempts, use of cessation treatments, and quit rates (*3*,*5*,*6*).

These findings indicate that state Medicaid coverage of tobacco cessation counseling is lagging behind coverage of cessation medications. State Medicaid programs can increase tobacco cessation among Medicaid enrollees by covering cessation counseling along with cessation medications; the combined use of these treatments is more effective in increasing quit rates than is the use of either treatment alone (*3*). However, requiring Medicaid enrollees to obtain counseling as a precondition for receiving medications has the potential to decrease enrollees' use of medications (*10*). State Medicaid programs can further increase the number of enrollees who quit smoking by promoting covered treatments to Medicaid enrollees and their health care providers to increase use of these treatments.

The findings in this report are subject to at least three limitations. First, in cases where official documents were not publicly available or were outdated or conflicting, American Lung Association personnel consulted state government personnel for clarification; the information they provided might have been inaccurate in some cases. Second, cessation coverage can vary widely across Medicaid managed care plans, and these plans and their cessation coverage can change over time, making it challenging to determine state Medicaid managed care plan cessation coverage. Finally, this report does not assess promotion, awareness, or use of state Medicaid cessation coverage.

Approximately 7.9 million adult smokers are estimated to be enrolled in Medicaid (*1*).[¶¶] The disproportionately high cigarette smoking prevalence among Medicaid enrollees imposes a substantial health burden on society and is a major driver of federal and state health care expenditures. Smoking-related diseases accounted for approximately 15% of annual Medicaid spending during 2006–2010, amounting to approximately $39 billion in 2010 (*2*). State Medicaid programs can maximize tobacco cessation among Medicaid enrollees, which would be expected to reduce this health and financial burden by covering all evidence-based cessation treatments, removing barriers that impede access to these treatments, promoting covered treatments to Medicaid enrollees and their health care providers to increase use of these treatments, and monitoring use of covered treatments (*5*–*7*).

Summary

What is already known about this topic?

Medicaid enrollees smoke cigarettes at a higher rate than do privately insured U.S. residents (25.3% versus 11.8%). Comprehensive state Medicaid cessation coverage has the potential to reduce smoking, smoking-related disease, and health care expenditures among Medicaid enrollees. A *Healthy People 2020* objective calls for comprehensive tobacco cessation treatment coverage in all 50 states and the District of Columbia.

What is added by this report?

Although progress occurred in state Medicaid tobacco cessation coverage during 2015–2017, coverage continues to fall short of the target set by the *Healthy People 2020* objective. As of June 30, 2017, 10 states covered all nine evidence-based cessation treatments considered in this study for all Medicaid enrollees, up from nine states in 2015. All but one of these 10 states had barriers to accessing some treatments. As of June 30, 2017, 32 states covered all seven FDA-approved cessation medications, and 33 states covered individual cessation counseling, with 10 of the latter states also covering group counseling.

What are the implications for public health practice?

State Medicaid programs can help Medicaid enrollees quit smoking by covering all evidence-based cessation treatments, removing barriers that make it difficult for enrollees to access these treatments, and promoting covered treatments to increase their use.

[§§] Effective January 2014, section 2502 of the 2010 Patient Protection and Affordable Care Act barred state Medicaid programs from excluding FDA-approved cessation medications from coverage: Patient Protection and Affordable Care Act of 2010. Pub. L. No. 114–48 (March 23, 2010, as amended through May 1, 2010 (http://housedocs.house.gov/energycommerce/ppacacon.pdf). The Centers for Medicare & Medicaid Services has issued guidance to states on implementing this provision (https://www.medicaid.gov/Medicaid-CHIP-Program-Information/By-Topics/Prescription-Drugs/Downloads/Rx-Releases/State-Releases/state-rel-165.pdf). As of June 30, 2017, the Centers for Medicare & Medicaid Services had published state plan amendments from 37 states declaring that they have implemented this provision.

[¶¶] This estimate includes both traditional and expansion Medicaid enrollees.

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Conflict of Interest

Anne DiGiulio reports grants from Pfizer, the Pharmaceutical Research and Manufacturers of America (PhRMA), and the University of Texas MD Anderson Cancer Center, outside the submitted work; Zach Jump reports grants from Pfizer, outside the submitted work; Annie Yu reports grants from Pfizer and PhRMA, outside the submitted work. No other conflicts of interest were reported.

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Vital Signs: Containment of Novel Multidrug-Resistant Organisms and Resistance Mechanisms — United States, 2006–2017

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Abstract

Background: Approaches to controlling emerging antibiotic resistance in health care settings have evolved over time. When resistance to broad-spectrum antimicrobials mediated by extended-spectrum β-lactamases (ESBLs) arose in the 1980s, targeted interventions to slow spread were not widely promoted. However, when Enterobacteriaceae with carbapenemases that confer resistance to carbapenem antibiotics emerged, directed control efforts were recommended. These distinct approaches could have resulted in differences in spread of these two pathogens. CDC evaluated these possible changes along with initial findings of an enhanced antibiotic resistance detection and control strategy that builds on interventions developed to control carbapenem resistance.

Methods: Infection data from the National Healthcare Safety Network from 2006–2015 were analyzed to calculate changes in the annual proportion of selected pathogens that were nonsusceptible to extended-spectrum cephalosporins (ESBL phenotype) or resistant to carbapenems (carbapenem-resistant Enterobacteriaceae [CRE]). Testing results for CRE and carbapenem-resistant *Pseudomonas aeruginosa* (CRPA) are also reported.

Results: The percentage of ESBL phenotype Enterobacteriaceae decreased by 2% per year (risk ratio [RR] = 0.98, p<0.001); by comparison, the CRE percentage decreased by 15% per year (RR = 0.85, p<0.01). From January to September 2017, carbapenemase testing was performed for 4,442 CRE and 1,334 CRPA isolates; 32% and 1.9%, respectively, were carbapenemase producers. In response, 1,489 screening tests were performed to identify asymptomatic carriers; 171 (11%) were positive.

Conclusions: The proportion of Enterobacteriaceae infections that were CRE remained lower and decreased more over time than the proportion that were ESBL phenotype. This difference might be explained by the more directed control efforts implemented to slow transmission of CRE than those applied for ESBL-producing strains. Increased detection and aggressive early response to emerging antibiotic resistance threats have the potential to slow further spread.

Introduction

The emergence and spread of antibiotic resistance threatens to outpace the development of new antimicrobials, and slowing the spread of these organisms has become a priority. Among Enterobacteriaceae, the family of pathogens most frequently associated with health care–associated infections (*1*), resistance to the broad-spectrum antimicrobials extended-spectrum cephalosporins and carbapenems has been driven largely by the spread of plasmid-mediated resistance genes encoding extended-spectrum β-lactamases (ESBLs) and carbapenemases, respectively. In the United States, ESBL-producing Enterobacteriaceae were first reported in 1988 (*2*). The emergence of these ESBL-producing isolates limited the options available for treatment, but these organisms remained susceptible to some first-line therapies, including carbapenems. In general, facilities independently selected approaches to control spread, which often included core infection control practices, such as hand hygiene, and placing patients with ESBL-producing strains in single rooms under Contact Precautions.

Enterobacteriaceae resistance to even broader spectrum antimicrobials, including carbapenems, was reported with increasing frequency beginning in 2001 (*3*). Rapid spread of these carbapenem-resistant Enterobacteriaceae (CRE) in parts of the United States and other countries (*4*,*5*) highlighted a need to more aggressively control CRE transmission. In 2009, CDC created CRE-specific guidance, which was endorsed by the Healthcare Infection Control Practices Advisory

Committee (*6*). This guidance included recommendations for additional interventions when CRE was identified at a health care facility, including laboratory surveillance of clinical cultures and targeted patient screening to identify health care contacts with asymptomatic colonization. This CRE-specific guidance was updated in 2013 and 2015 (https://www.cdc.gov/hai/organisms/cre/cre-toolkit/index.html) and was highlighted by CDC in a 2013 report (*7*).

In 2017, CDC outlined a new effort to react rapidly to novel multidrug-resistant organisms (*8*); this approach includes encouraging health care facilities and public health authorities to respond to single isolates of an emerging antibiotic-resistant pathogen. The strategy rests on these five pillars: 1) rapid detection of targeted pathogens and their resistance mechanisms, 2) on-site infection control assessments by trained experts to identify gaps in infection prevention, 3) screening of exposed contacts to identify asymptomatic colonization, 4) coordination of the response among facilities, and 5) continuing these interventions until transmission is controlled. Detection and control efforts can extend from the index facility to other facilities that share patients.

To support this approach, CDC established the Antibiotic Resistance Laboratory Network (ARLN) (https://www.cdc.gov/drugresistance/solutions-initiative/ar-lab-networks.html) to improve national capacity to rapidly detect and respond to antibiotic resistance. ARLN provides carbapenemase testing for two emerging antibiotic resistant pathogens, CRE and carbapenem-resistant *Pseudomonas aeruginosa* (CRPA), at 56 state and local public health laboratories and screening for asymptomatic CRE and CRPA carriage at seven regional laboratories (*9*). Carbapenemase-producing strains were targeted for detection and response in part because of their previously demonstrated propensity for spread. CDC also expanded funding to state and local health departments to increase capacity and build expertise in responding to these and other emerging antibiotic resistance threats.

For this report, data from a national health care–associated infections surveillance system were reviewed to determine if the more directed approach applied for CRE was associated with differences in the percentage of Enterobacteriacae health care–associated infections that were CRE compared with those that had the ESBL phenotype. In addition, findings from the first 9 months of the enhanced response to emerging resistant organisms are described.

Methods

Percentage of Enterobacteriaceae with CRE or ESBL phenotypes in the National Healthcare Safety Network, 2006–2015. Included in the analysis were central line–associated bloodstream infections (CLABSIs) and catheter-associated urinary tract infections (CAUTIs) associated with *Escherichia coli* or *Klebsiella pneumoniae* and reported to CDC's National Healthcare Safety Network (NHSN) during 2006–2015 from adult medical, surgical, or medical/surgical intensive care units at short-stay acute care hospitals. The Centers for Medicare & Medicaid Services' (CMS) Hospital Inpatient Quality Reporting Program mandated reporting of CLABSI and CAUTI data to NHSN starting in 2011 and 2012, respectively; data from previous years represent voluntary reporting or reporting to comply with state or local mandates. National pooled mean percentages for Enterobacteriaceae with CRE phenotype (isolates resistant to imipenem, meropenem, doripenem, or ertapenem), and ESBL phenotype (isolates that tested intermediate or susceptible to carbapenems and intermediate or resistant to ceftazidime, cefepime, ceftriaxone, or cefotaxime) were calculated. Log binomial regression models were used to estimate the average annual change in the proportion of *E. coli* and *K. pneumoniae* that had a CRE or ESBL phenotype. P-values <0.05 were considered statistically significant. Sensitivity analyses were performed to account for the change in hospitals reporting to NHSN each year. The results of the log binomial regression model were confirmed by a robust variance Poisson model.

Enhanced detection and response. CRE and CRPA (*P. aeruginosa* resistant to imipenem, meropenem, or doripenem) isolates were submitted to ARLN laboratories for testing for carbapenemases. Among Enterobacteriaceae, *E. coli, K. oxytoca, K. pneumoniae*, and *Enterobacter* spp. were targeted for submission. Testing at ARLN laboratories included carbapenemase production testing and molecular detection of genes encoding for the five carbapenemases of primary public health concern: *Klebsiella pneumoniae* carbapenemase (KPC), New Delhi metallo-beta-lactamase (NDM), Verona integron encoded metallo-beta-lactamase (VIM), imipenemase (IMP), and oxacillinase-48-like carbapenemase (OXA-48). ARLN laboratories were asked to report positive findings to local public health authorities and CDC within 1 day and to submit testing summaries to CDC monthly.

For each carbapenemase-producing isolate detected, CDC guidance recommends that state health department staff members contact the health care facility to review infection control measures and consider performing on-site infection control assessments. If indicated, contacts of the index patient are screened to detect transmission; testing capacity for this screening is provided through ARLN. Response activities continue until transmission is controlled. Screening results were stratified by whether the screening took place in a short-stay acute care hospital or a post–acute care facility (i.e., long-term acute care hospital or nursing home).

Results

Percentage of Enterobacteriaceae with CRE or ESBL phenotypes in the National Healthcare Safety Network, 2006–2015. Among short-stay acute care hospitals, the percentage of *Klebsiella* and *E. coli* isolates with the ESBL phenotype remained relatively stable, ranging from 17.6% (116 of 659 isolates) in 2006 to 16.5% (694 of 4,211) in 2015, with a peak of 18.9% in 2009 (Figure 1). The percentage of CRE declined from 8.8% (35 of 397 isolates) in 2006 and 10.6% (64 of 604) in 2007 to 3.1% (115 of 3,718) in 2015 (Figure 2). During 2006–2015, the annual percentage of isolates with the ESBL phenotype declined an average of 2% (RR = 0.98, p = 0.009); during the same period, the proportion that were CRE decreased 15% per year (RR = 0.85, p<0.001). Results were unchanged when the analysis was limited to facilities that reported in all years.

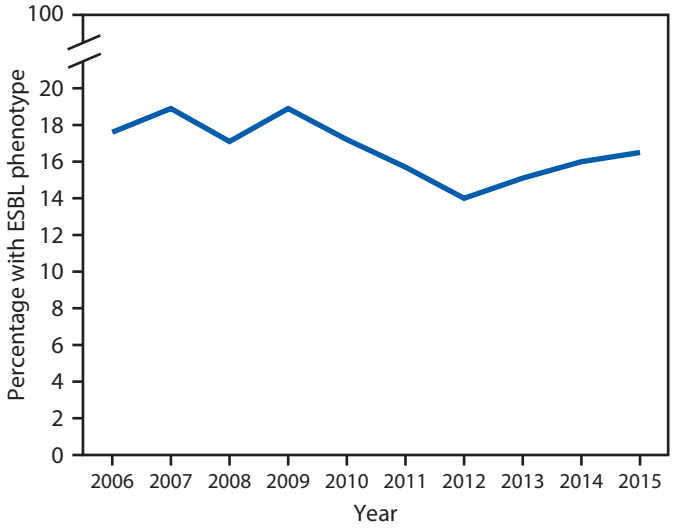
Enhanced detection of and response to carbapenemase-producing organisms. During the first 9 months of 2017, among 4,442 CRE and 1,334 CRPA isolates that were tested for carbapenemases from 32 states, 1,401 (32%) CRE and 25 (1.9%) CRPA were carbapenemase producers (Table 1). Among the carbapenemase-producing isolates, 221 (15.5%) expressed carbapenemases other than KPC. Of isolates tested, 1,422 (25%) were collected in the first quarter of 2017, 2,141 (37%) in the second quarter, and 2,213 (38%) in the third quarter. During this period, the median time from specimen collection to CDC notification decreased from 37 to 13 days. The percentage of carbapenemase-producing isolates varied by organism and was highest among *Klebsiella* species (65%). Among carbapenemase-producing CRE, the most commonly identified carbapenemase was KPC (1,232 of 1,401 isolates, 88%); VIM was the most common carbapenemase identified in CRPA (18 of 25, 72%) (Table 1).

To identify asymptomatically colonized health care contacts of index patients, 1,489 screening tests for carbapenemases were performed during 70 surveys (defined as all screening tests performed at a single facility within a 14-day period) in 50 facilities. A median of 10.5 contacts (interquartile range = 2–25) were screened per survey. Overall, 11% of screening tests were positive for at least one of the five carbapenemases of primary public health concern (Table 2). A higher percentage of post–acute care facility contacts screened positive for carbapenemases (14% [147 of 1,074 contacts]) than did contacts from short-stay acute care hospitals (5.8% [21 of 365]) (p<0.01). Screening tests performed increased from 363 in the first quarter of 2017, to 732 in the third.

Illustrative examples. Public health responses using this new approach have identified single cases without transmission, transmission within facilities, and spread to multiple facilities. Examples from two states are presented to illustrate these efforts.

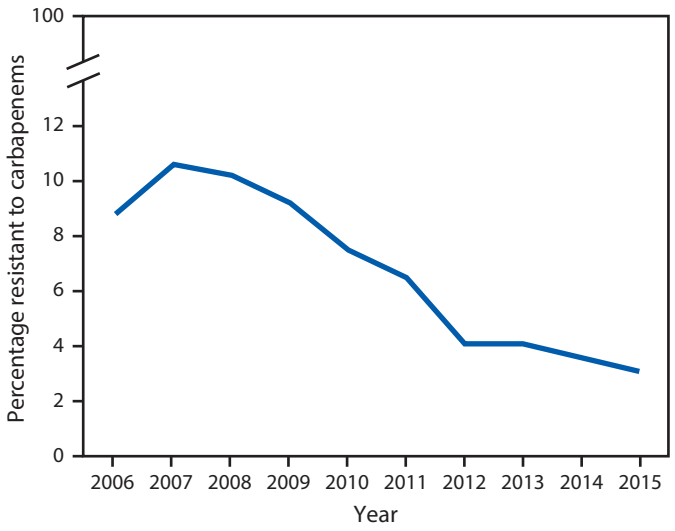
In October 2017, the Tennessee Department of Health contacted CDC regarding identification of an NDM and OXA-48–producing *Klebsiella pneumoniae* isolate through ARLN.

FIGURE 1. Percentage of *Escherichia coli* and *Klebsiella pneumoniae* isolates from selected health care–associated infections* with the extended-spectrum-β-lactamase (ESBL) phenotype reported as nonsusceptible to extended-spectrum cephalosporins† — National Healthcare Safety Network, United States, 2006–2015



* Central line–associated bloodstream infections and catheter-associated urinary tract infections.
† Nonsusceptible to at least one extended-spectrum cephalosporin.

FIGURE 2. Percentage of *Escherichia coli* and *Klebsiella pneumoniae* isolates from selected health care–associated infections* reported as resistant to a carbapenem — National Healthcare Safety Network, United States, 2006–2015



* Central line–associated bloodstream infections and catheter-associated urinary tract infections.

Infection control assessment and screening of hospital contacts was completed and results returned within 48 hours of identification of carbapenemase presence. No transmission was identified. Because the index patient had a recent health care exposure in another country, ARLN regional laboratories expanded their services to perform CDC-recommended admission screening for patients with a history of overnight health care stays outside the United States during the preceding 6 months (*10*).

In April 2017, the Iowa Department of Public Health contacted CDC regarding IMP identified in a *Proteus* species isolated from a nursing home resident. The state health department assessed infection control practices and performed a point prevalence survey that identified five additional colonized residents among 30 surveyed at the nursing home. The health department conducted additional infection control assessments to ensure adherence to recommended practices and two follow-up surveys of the nursing home wing, which did not identify any additional cases.

Conclusions and Comments

Although the proportion of *Klebsiella* spp. and *E. coli* that had either an ESBL or CRE phenotype both declined during 2006–2015, larger decreases and a lower overall percent resistant were observed for the CRE phenotype. This difference might be attributable, at least in part, to the more directed response employed to slow the spread of CRE once it was identified. Although CDC's containment approach had not yet been fully initiated when the decline in CRE began, these data suggest that an early aggressive response, as outlined in CRE-specific infection prevention recommendations released beginning in 2009 (*6*), can slow emergence and even decrease the occurrence of infections from resistant pathogens. As laboratory capacity improved, ARLN testing volume and public health responses increased over the first three quarters of 2017, demonstrating that recent investments in detection and response capacity are facilitating prompt identification of and response to emerging resistant organisms. Notably, 221 isolates with non-KPC carbapenemases were identified; these rare forms of resistance have the potential to add to the U.S. CRE burden and represent an important opportunity to prevent the spread of novel resistance at its earliest stage. Findings from these enhanced prevention efforts are being used to further refine detection and prevention strategies.

Contact screening identified previously undetected transmission and appeared to have the highest yield in post–acute care facilities with higher acuity patients. Challenges in these settings that might facilitate transmission of resistant organisms include long duration of facility stay, less aggressive use of transmission-based precautions because of concerns about resident quality of life, high staff turnover rates, and less expertise and training in infection control. Previous work has also identified these settings as potential amplifiers of CRE transmission (*11*), underscoring the importance of providing ongoing support to these facilities when targeted resistant organisms are identified. This support includes infection control assessments to improve adherence to recommended interventions and screening of contacts to identify asymptomatic carriers.

Although this analysis focused on carbapenemase-producing organisms, the containment strategy can prevent the spread of other emerging antimicrobial resistant pathogens, including *Candida auris* and pan-resistant bacteria. Using existing surveillance systems, including ARLN, further work is under way to better identify and understand new threats, including those that are emerging outside the United States. CDC continues to work to develop tests for new resistance mechanisms that can be made available via ARLN. Resistance is constantly evolving, and the containment strategy and ARLN are designed to be flexible and nimble to rapidly detect and respond to new threats.

TABLE 1. Carbapenemase testing, by organism — Antibiotic Resistance Laboratory Network laboratories and CDC laboratory, specimens collected January 1–September 30, 2017

	Total		KPC		NDM		OXA-48		VIM		IMP	
Organism	Tested* no.	Positive† no. (%)	Tested no.	Positive no. (%)	Tested no.	Positive no. (%)	Tested no.	Positive no. (%)	Tested no.	Positive no. (%)	Tested no.	Positive no. (%)
Total	**5,776**	**1,426 (25)**	5,755	1,234 (21)	5,570	134 (2.4)	5,323	65 (1.2)	4,724	30 (0.6)	4,068	16 (0.4)
Enterobacteriaceae	**4,442**	**1,401§ (32)**	4,430	1,232 (28)	4,247	134 (3.2)	4,050	65 (1.6)	3,448	12 (0.3)	2,827	11 (0.4)
Klebsiella spp.	**1,439**	**942 (65)**	1,437	862 (60)	1,359	74 (5.4)	1,295	42 (3.2)	1114	4 (0.4)	744	1 (0.1)
E. coli	**789**	**144 (18)**	783	83 (11)	755	43 (5.7)	719	20 (2.8)	665	0 (0)	585	0 (0)
Enterobacter spp.	**1,538**	**201 (13)**	1,537	194 (13)	1,468	14 (1.0)	1,387	0 (0)	1,201	0 (0)	1,063	3 (0.3)
Other	**346**	**72 (21)**	345	53 (15)	336	3 (0.9)	322	2 (0.6)	256	7 (2.7)	238	7 (2.9)
Unspecified	**330**	**42 (13)**	328	40 (12)	329	0 (0)	327	1 (0.3)	212	1 (0.5)	197	0 (0)
Pseudomonas aeruginosa	**1,334**	**25§ (1.9)**	1,325	2 (0.2)	1,323	0 (0)	1,273	0 (0.0)	1,276	18 (1.4)	1,241	5 (0.4)

Abbreviations: IMP = imipenemase; KPC = *Klebsiella pneumoniae* carbapenemase; NDM = New Delhi metallo-beta-lactamase; OXA-48 = oxacillinase-48-like carbapenemase; VIM = Verona integron encoded metallo-beta-lactamase.

* Number of isolates tested.

† Positive for at least one of the five carbapenemases tested (IMP, KPC, NDM, OXA-48, or VIM).

§ 53 isolates were positive for more than one mechanism tested (28 KPC and NDM; 24 NDM and OXA-48; one KPC and VIM).

Despite improvements in capacity to detect carbapenemases in clinical isolates and asymptomatic carriers through ARLN, challenges remain. Transmission in one facility in a region has the potential to affect all of the facilities and patients in a region through patient sharing; therefore, recognition by health care facilities of the importance of an aggressive, early, and coordinated response is needed to ensure responses are timely and comprehensive. Mathematic modeling of the containment strategy based on a single U.S. state's patient transfer network suggests that an intervention resulting in a 20% reduction in transmission would result in approximately 1,600 fewer clinical cases, a relative reduction of about 76%, 3 years after introduction (CDC, unpublished data, 2018). In addition, commitment from health care personnel and health care facilities to improve adherence to infection control interventions that can prevent transmission, especially in post–acute care settings, is necessary to prevent amplification of emerging resistance. For situations in which a targeted form of antimicrobial resistance has emerged more widely in a region, containment strategies might be less effective; additional work is required for these situations to identify the optimal strategies to reduce the prevalence of endemic resistant organisms. Finally, current interventions are challenging to implement and sustain; new interventions to reduce transmission are needed to supplement currently available prevention measures.

Public health departments, because of their expertise and ability to work across health care facilities, are uniquely positioned to facilitate these responses to emerging antimicrobial resistance. Since 2009, CDC has provided resources to develop state and local health care–associated infection programs; currently, CDC supports approximately 500 persons in state and local health departments to work on health care-associated infections and antimicrobial resistance. Details on funding provided to each state to combat antimicrobial resistance are provided in CDC's antimicrobial resistance map (https://wwwn.cdc.gov/arinvestments).

The findings in this report are subject to at least four limitations. First, resistance data in NHSN are collected using the final interpretations of resistant, intermediate, or sensitive, and this analysis does not account for differences among laboratories in the breakpoints used for interpretation or for changes in breakpoints over time. Enterobacteriaceae breakpoints for carbapenems and some cephalosporins were lowered during the analysis period. This might have resulted in an increase in isolates reported as resistant in later years of this analysis and could have resulted in an underestimation of any reductions in CRE or ESBLs described. Second, NHSN data analyzed for this report represent only isolates from two infection types (CAUTI and CLABSI); changes in colonization or other infection types would not be identified. Third, although greater reductions were seen in the percentage of organisms that were CRE compared to those with the ESBL phenotype, this analysis is unable to identify the exact cause for this difference. Finally, some states and health care facilities with colonization testing capacity chose to perform screening in-house rather than through the ARLN regional laboratory; these tests are not reported to ARLN and therefore are not included in this report, resulting in an underestimation of the true volume of screening conducted.

Limiting the spread of emerging forms of antibiotic resistance is a public health priority, and a timely and coordinated effort among health care facilities, local and state health departments, and CDC is needed to accomplish this goal. Research is already under way to expand control strategies through innovative approaches such as patient decolonization and microbiome manipulation, along with a focus on identifying strategies to decrease the time from specimen collection to public health response. Fortunately, with the parallel development of an enhanced prevention strategy for emerging antimicrobial resistance and implementation of advanced laboratory testing in ARLN, the critical tools for controlling the spread of antimicrobial resistance are now available nationwide. In the first year of ARLN implementation, CDC and state and local public health departments and public health laboratory partners

TABLE 2. Screening tests for carbapenem-resistant Enterobacteriaceae colonization, by facility type — Antibiotic Resistance Laboratory Network laboratories and CDC laboratory, specimens collected January 1–September 30, 2017

	Total*		Post–acute care facility†		Short-stay acute care hospital	
Carbapenemase	Screened§ no.	Positive no. (%)	Screened no.	Positive no. (%)	Screened no.	Positive no. (%)
Total	**1,489**	**171¶ (11)**	1,074	147 (14)	365	21 (5.8)
KPC	**1,480**	**122 (8.2)**	1,065	103 (10)	365	16 (4.4)
NDM	**1,480**	**6 (0.4)**	1,065	6 (0.6)	365	0 (0)
OXA-48	**1,311**	**0 (0)**	896	0 (0)	365	0 (0)
VIM	**1,488**	**34 (2.3)**	1,073	30 (2.8)	365	4 (1.1)
IMP	**1,311**	**9 (0.7)**	896	8 (0.9)	365	1 (0.3)

Abbreviations: IMP = imipenemase; KPC = *Klebsiella pneumoniae* carbapenemase; NDM = New Delhi metallo-beta-lactamase; OXA-48 = oxacillinase-48-like carbapenemase; VIM = Verona integron encoded metallo-beta-lactamase.

* Includes 50 screening tests without a reported facility type, three of which were positive for KPC.

† Includes long-term acute care facilities, skilled nursing facilities, and inpatient rehabilitation facilities.

§ Number screened refers to individual screening tests. Not all screening swabs were tested for all five mechanisms.

¶ Seven tests were positive for more than one mechanism tested (four KPC and NDM, and three KPC and VIM).

Key Points

- The emergence and spread of antibiotic resistance threatens to outpace the development of new antibiotics. Slowing the spread of emerging resistance is a CDC priority to protect persons and help slow the development of antibiotic resistance overall.
- Infection data from the National Healthcare Safety Network from 2006-2015 were analyzed to calculate changes in the annual proportion of selected pathogens that were nonsusceptible to extended-spectrum cephalosporins (ESBL phenotype) or resistant to carbapenems (carbapenem-resistant Enterobacteriaceae [CRE]).
- The percentage of ESBL phenotype Enterobacteriaceae decreased by 2% per year; by comparison, the CRE percentage decreased by 15% per year.
- The proportion of Enterobacteriaceae infections that were CRE remained lower and decreased more over time than the proportion that were ESBL phenotype. This difference might be explained by the more directed control efforts implemented to slow transmission of CRE than those applied for ESBL-producing strains.
- These data suggest that an early aggressive response, as outlined in CRE-specific infection prevention recommendations released beginning in 2009, can slow emergence and even decrease the occurrence of infections from resistant pathogens.
- In 2017, CDC outlined a new effort to react rapidly to novel multidrug-resistant organisms; this approach includes encouraging health care facilities and public health authorities to respond to even single isolates of an emerging antibiotic-resistant pathogen.
- From January to September 2017, carbapenemase testing was performed by the Antibiotic Resistance Lab Network for 4,442 CRE and 1,334 carbapenem-resistant *Pseudomonas aeruginosa* (CRPA) isolates; 32% and 1.9%, respectively were carbapenemase-producers. Among the carbapenemase-producing isolates, 221 (15.5%) expressed carbapenemases other than *Klebsiella pneumoniae* carbapenemase. Carbapenemases can make germs resistant to some of our most powerful drugs, carbapenems.
- Additional information is available at https://www.cdc.gov/vitalsigns/.

have effectively increased the capacity to identify and respond to high concern organisms to prevent transmission of resistant pathogens. Although some challenges remain, this national public health strategy represents a critical step in the effort to decrease the impact of resistant pathogens.

Acknowledgments

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Conflict of Interest

No conflicts of interest were reported.

[1]Division of Healthcare Quality Promotion, National Center for Emerging and Zoonotic Diseases, CDC; [2]Tennessee Department of Health; [3]Iowa Department of Public Health.

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Notes from the Field:

Pharmacy Needs After a Natural Disaster — Puerto Rico, September–October 2017

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After disasters such as hurricanes, access to prescription drugs might be limited or inaccessible. For example, after Hurricane Ivan made landfall near Mobile, Alabama, in 2004, an assessment of its impact on pharmacies in the affected areas found that 53% had depleted supplies and at least 26% had to prioritize distribution to patients because of limited supplies (*1*). A 2005 study of Hurricane Katrina evacuees in San Antonio, Texas, found that disaster medical assistance teams were more prepared to provide for acute than chronic illnesses although more than two thirds (68%) of patients requested drugs to treat chronic conditions (*2*). Understanding the prescribing practices of a region can inform post-disaster medication needs and planning for future emergencies.

On September 20, 2017, Hurricane Maria made landfall in Puerto Rico as a Category 4 hurricane. Five days later, only approximately 29% of pharmacies reporting to Healthcare Ready, an organization that provides information on access to pharmacies during an emergency, were open (*3*). CDC summarized data within the IQVIA data source (formerly IMSHealth, QuintilesIMS)* to supply the U.S. Department of Health and Human Services emergency response team with projections of formulary health care needs following Hurricane Maria. Prescription data can also highlight important chronic disease concerns for a community.

The IQVIA database contains information on drugs dispensed by retail facilities and is normally used by industry to monitor drug use and trends in the market. Information on the top 200 drugs dispensed by retail facilities in Puerto Rico during June–August was abstracted from the database. An average of total prescriptions for these 200 drugs for the 3-month period was calculated. The top 200 drugs accounted for approximately 80% of all prescription drugs dispensed in retail facilities. Drugs were categorized by therapeutic category and administration route (e.g., oral, inhalation, or topical) by a team of clinicians at CDC.

During June–August 2017, the top categories of drugs prescribed were for cardiovascular (average = 21% of prescriptions filled), psychiatric (12%), and analgesic (10%) drugs (Table). Among the cardiovascular drugs prescribed, a majority were angiotensin II receptor antagonists (29%), beta blockers (20%), and angiotensin-converting enzyme (ACE) inhibitors (18%). The most frequently dispensed individual drugs were thyroid replacement hormones (230,324 prescriptions dispensed, 5% of total dispensed), gabapentin (144,114 prescriptions dispensed, 3% of total), and metformin (141,734 prescriptions dispensed, 3% of total). Ninety percent of prescribed drugs were for oral administration.

TABLE. Top therapeutic categories for retail-dispensed prescriptions — Puerto Rico, June–August, 2017*

Therapeutic category	No. (%) prescriptions
Cardiovascular	971,234 (20.7)
Psychiatric	554,839 (11.8)
Analgesic†	449,532 (9.6)
Lipid lowering	349,533 (7.5)
Diabetes	346,104 (7.4)
Gastrointestinal	342,146 (7.3)
Neurologic	287,038 (6.1)
Thyroid	234,982 (5.0)
Antibiotics	225,009 (4.8)
Pulmonary	150,525 (3.2)
Other§	781,241 (16.6)
Total	**4,692,183 (100.0)**

* Categorizations represent the therapeutic categories for the top 200 dispensed medications, information about which was abstracted from the IQVIA database for this analysis. The top 200 dispensed medications account for approximately 80% of the total prescriptions dispensed in Puerto Rico.
† Includes prescriptions for narcotics and other medications used for pain management (e.g., pregabalin, acetaminophen, phenyltoloxamine, and tramadol).
§ Includes antihistamines, diuretics, muscle relaxants, nutritional supplements, ophthalmic solutions, medications for enlarged prostate/benign prostatic hyperplasia, rheumatologic, steroids, and topical creams.

The distribution of pharmaceutical dispensing practices identified using the IQVIA database can provide information for planning both before and after a disaster. The most frequently prescribed drugs help focus immediate supply measures for response and recovery efforts, supporting a vital public health need. The IQVIA database used in this analysis is limited to retail facilities and does not include hospitals or other institutions such as nursing homes. Furthermore, some critical drugs might not be represented in this data set, including insulin, which can also be purchased over the counter; hence, some of the prescribed quantities in this data set could be an underestimate of medication needs. Although insulin was not a most frequently purchased or prescribed drug, it is a daily need for persons with insulin-dependent diabetes and should be prioritized. To have a more complete picture of important drugs that might be needed after a disaster, multiple data sources, including drug sales data to hospitals, clinics, and nursing homes, as well as information provided by third-party claims adjudication data, could be analyzed to inform public health activities and guide collaborations with drug suppliers to respond to and recover from large-scale disasters.

* https://www.iqvia.com/locations/united-states/government-segment.

Conflict of Interest

No conflicts of interest were reported.

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Erratum:

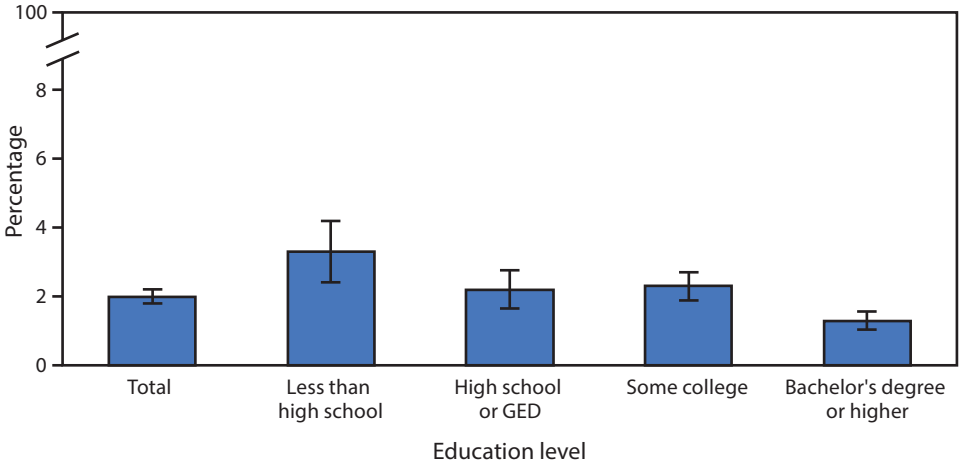
Vol. 67, No. 7

In the report "Self-Reported Receipt of Advice and Action Taken To Reduce Dietary Sodium Among Adults With and Without Hypertension — Nine States and Puerto Rico, 2015," on page 225, the third sentence of the second paragraph should have read "Median survey response rate for all states and territories included in this analysis was 51.3% (**range = 38.6%–59.0%**) (*5*)."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Percentage* of Adults Aged ≥25 Years Who Were Told in the Past 12 Months by a Doctor or Other Health Professional That They Had a Liver Condition,† by Education Level — National Health Interview Survey,§ 2016



Abbreviation: GED = General Educational Development high school equivalency diploma.

* With 95% confidence intervals shown with error bars. Estimates are age-adjusted to the projected 2000 U.S. population as the standard population using four age groups: 25–44, 45–64, 65–74, and ≥75 years.

† Information on liver condition is based on a positive response to the survey question "During the past 12 months, have you been told by a doctor or other health professional that you had any kind of liver condition?"

§ 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 2016, 2.0% of adults aged ≥25 years who were surveyed had been told by a doctor or other health professional in the past 12 months that they had a liver condition. The prevalence of liver condition declined as education level increased. Adults who had completed a bachelor's degree or higher were the least likely to have been diagnosed with any liver condition (1.3%), whereas those without a high school diploma were the most likely (3.3%).

Source: Tables of summary health statistics for U.S. adults, National Health Interview Survey, 2016. https://www.cdc.gov/nchs/nhis/SHS/tables.htm.

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