Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 69 / No. 20
May 22, 2020

Outbreak of Norovirus Illness Among Wildfire Evacuation Shelter Populations — Butte and Glenn Counties, California, November 2018

Ellora Karmarkar, MD[1,2]; Seema Jain, MD[2]; Jeff Higa, MPH[2]; Jazmin Fontenot, MPH[2]; Regina Bertolucci[3]; Thalia Huynh[2]; Gwendolyn Hammer, PhD[2]; Alice Brodkin[2]; May Thao[3]; Blake Brousseau[3]; Danielle Hopkins[3]; Emily Kelly, MSc[2]; Madison Sheffield, MPH[2]; Sandy Henley, MS[3]; Holly Whittaker, MS[4]; Robert L. Herrick, PhD[5]; Chao-Yang Pan, MPH[2]; Alice Chen, MPH[2]; Janice Kim, MD[2]; Lori Schaumleffel[2]; Zenith Khwaja[2]; Erin Epson, MD[2]; Shua J. Chai, MD[2,6]; Debra Wadford, PhD[2]; Duc Vugia, MD[2]; Linda Lewis, DVM[3]

The Camp Fire, California's deadliest wildfire, began November 8, 2018, and was extinguished November 25 (*1*). Approximately 1,100 evacuees from the fire sought emergency shelter. On November 10, acute gastroenteritis (AGE) was reported in two evacuation shelters; norovirus illness was suspected, because it is commonly detected in shelter-associated AGE outbreaks. Norovirus is highly contagious and resistant to several disinfectants. Butte County Public Health Department (BCPHD), assisted by the California Department of Public Health (CDPH), initiated active surveillance to identify cases, confirm the etiology, and assess shelter infection prevention and control (IPC) practices to guide recommendations. During November 8–30, a total of 292 patients with AGE were identified among nine evacuation shelters; norovirus was detected in 16 of 17 unique patient stool specimens. Shelter IPC assessments revealed gaps in illness surveillance, isolation practices, cleaning, disinfection, and handwashing. CDPH and BCPHD collaborated with partner agencies to implement AGE screening, institute isolation protocols and 24-hour cleaning services, and promote proper hand hygiene. During disasters with limited resources, damaged infrastructure, and involvement of multiple organizations, establishing shelter disease surveillance and IPC is difficult. However, prioritizing effective surveillance and IPC at shelter activation is necessary to prevent, identify, and contain outbreaks.

Investigation and Results

Before the Camp Fire, approximately 230,000 persons resided in Butte County, California, in 2018, with 18% living below the federal poverty level (*2*). During November 8–25, the Camp Fire burned 153,336 acres, destroyed 18,793 structures (including one acute-care hospital and three skilled nursing facilities), displaced approximately 52,000 persons, and killed 85 (*1*). Nongovernmental organizations (NGOs) opened nine shelters in Butte (eight) and Glenn (one) counties that housed a total of approximately 1,100 evacuees. Evacuees stayed in shelter facilities (i.e., indoor evacuees) and shelter-associated parking lots (i.e., outdoor evacuees).

A probable case of norovirus illness was defined as AGE (vomiting or diarrhea) without laboratory confirmation or

INSIDE

Continuing Education examination available at https://www.cdc.gov/mmwr/mmwr_continuingEducation.html

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

other known cause of illness in a person associated with a shelter (evacuee or staff member) with onset on or after November 8, 2018; a confirmed norovirus case had a norovirus-positive stool specimen detected by real-time reverse transcription–polymerase chain reaction testing by the CDPH Viral and Rickettsial Disease Laboratory. BCPHD developed paper forms for shelter staff members to document patient illness onset dates, number of patients in isolation for AGE, and hospital or urgent care referrals. Shelter staff members triaged, isolated, and requested stool specimens from patients with AGE; specimen collection ceased after norovirus was confirmed in four shelters.

During November 8–30, a total of 292 cases of norovirus illness, including 16 confirmed and 276 probable cases, were identified in a fluctuating population of approximately 1,100 evacuees among eight of nine shelters (estimated attack rate = 27%). Evacuees joined and left shelters frequently, so shelters could only provide total census estimates. Twelve (4%) cases occurred in shelter staff members. The outbreak peaked on November 14, with the onset of 54 incident cases (Figure). During November 10–30, a total of 21 patients (7%) required evaluation in a hospital or urgent care facility; no deaths occurred. Among 255 (87%) patients with such data available, 131 (51%) were female; among 239 (82%) with age data, the median age was 63 years (interquartile range = 52–71 years). Sixteen (94%) of 17 unique patient stool specimens from four shelters were positive for norovirus and genotyped as GII.4 Sydney [P16].

Beginning November 17, CDPH and BCPHD regularly verified the number of AGE patients and assessed shelter IPC. IPC assessments at six shelters evaluated the availability of physically separate isolation facilities, including toilets; cleaning frequency; and shelter staff member norovirus IPC knowledge and practices. Guided by on-site observations, the more comprehensive CDC Shelter Assessment Tool (*3*) was adapted to focus on six areas: 1) environmental and kitchen practices, 2) illness screening protocols, 3) hand hygiene (including sink access), 4) facility cleanliness, 5) self-service practices for food and beverages, and 6) child play area cleanliness. Teams observed and documented staff member and evacuee adherence to handwashing before meals and before building entry and exit.

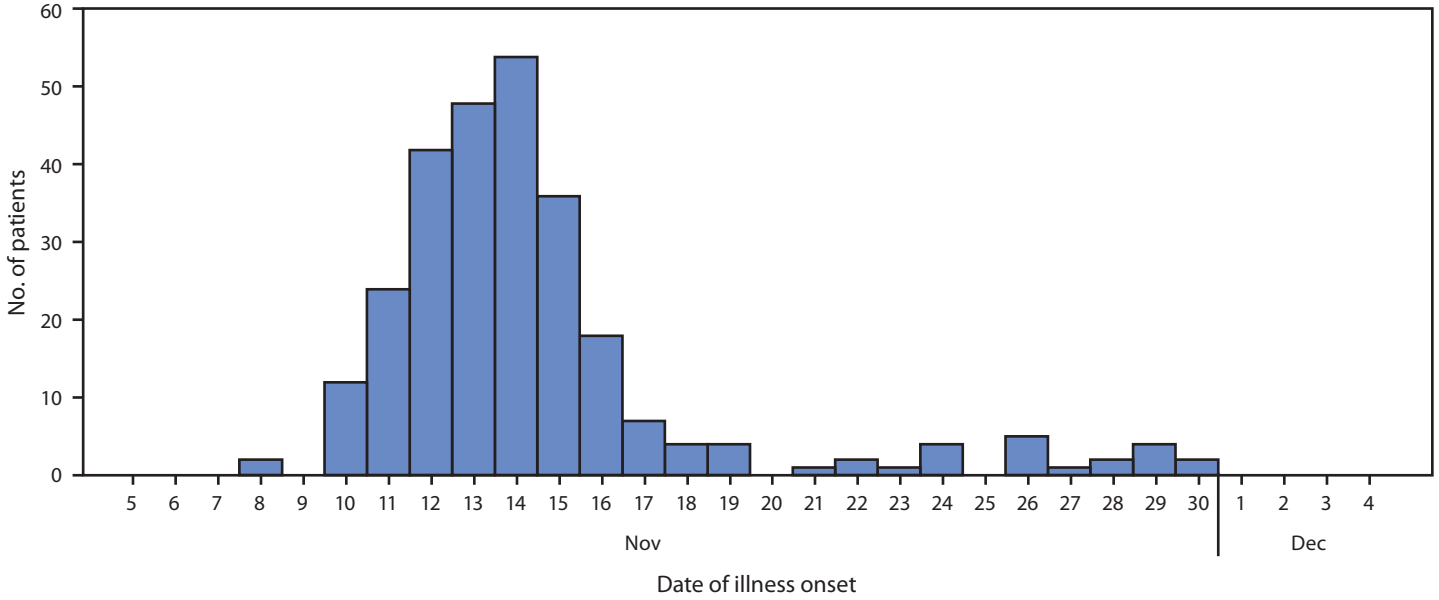
IPC assessments were conducted at six longer-term shelters among nine total shelters; three shelters needed assistance with ensuring adequate isolation areas, three had staff with limited knowledge about norovirus IPC, three needed separate toilets designated for persons with AGE, and two needed 24-hour professional cleaning services.

Shelter assessments that were more comprehensive were conducted at six of nine shelters during November 20–22 (Table). Only one shelter used comprehensive illness screening protocols for indoor or outdoor evacuees and visitors and had regular trash removal, and three had sinks for handwashing in dining areas. Three had ongoing food and beverage self-service, a potential risk factor for transmission. No shelter had IPC practices in child play areas. Public health teams observed

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

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2020;69:[inclusive page numbers].

FIGURE. Number of patients with probable or confirmed norovirus illness, by onset date among eight* Camp Fire evacuation shelter populations (N = 273)† — Butte and Glenn counties, California, November 8–30, 2018



* One shelter had no cases.
† Date of illness onset was missing for 19 patients.

100% handwashing adherence by staff and evacuees at one shelter; at five other shelters, observed handwashing adherence ranged from 0% to 50%.

Public Health Response

During this outbreak, BCPHD and CDPH collaborated with NGOs, the Emergency Medical Services Association of California, the Commissioned Corps of the U.S. Public Health Service, and medical providers to optimize AGE surveillance and IPC practices including isolation, cleaning, and handwashing. Initially, shelters relied on patient report for passive surveillance, and surveillance and isolation applied only to indoor evacuees. To improve AGE surveillance and isolation, CDPH and BCPHD integrated active AGE screening at evacuee registration and encouraged screening of all persons entering the shelter. Teams developed protocols emphasizing physically separate isolation areas and application of surveillance and IPC practices to both indoor and outdoor evacuees, staff members, and volunteers. Designated toileting and handwashing areas were available for ill persons, and meals were delivered to persons who were ill. The state emergency operations center coordinated deployment of multiple, staffed isolation tents to support medical care and surveillance.

Many evacuees and staff members were unaware that handwashing with soap and water, rather than hand sanitizer, is required to control norovirus transmission. Shelter staff members were advised to promote and monitor handwashing adherence. CDPH and BCPHD advocated for 24-hour cleaning services and daily trash removal and discouraged self-service of food and beverages to minimize norovirus transmission. IPC education was provided regularly because of frequent shelter staff turnover. IPC assessment teams supported shelter staff members in neighboring Sutter County, where AGE also was occurring in sheltered populations; however, no stool specimens were collected from Sutter County shelter evacuees to confirm the etiology.

TABLE. Initial and follow-up assessments of implemented infection prevention and control practices among Camp Fire evacuation shelters — Butte and Glenn Counties, California, November 20–30, 2018

	No. (%)	
	Initial assessment (six shelters*)	Final assessment (five shelters†)
Control practice	Nov. 20–22, 2018	Nov 29–30, 2018
Comprehensive illness screening protocols	1 (17)	5 (100)
Regular trash removal	1 (17)	5 (100)
Sinks in dining area	3 (50)	3 (60)
Prevention of food and beverage self-service	3 (50)	5 (100)
Child play area infection control	0 (0)	4 (80)

* Six of nine shelters.
† Five shelters remained in operation at the time of the final assessment.

Surveillance and IPC improved substantially with public health support. By November 29–30, all five remaining shelters in Butte and Glenn counties had comprehensive illness

screening, regular trash removal, and signage discouraging food and beverage self-service (Table). Four had IPC practices in the child play area. The outbreak gradually slowed, with no new onset of illness reported in the five remaining shelters after November 30. All original shelters closed in early December. A new shelter was opened to house the remaining evacuees, and AGE surveillance continued.

Discussion

In November 2018, norovirus outbreaks occurred in eight of nine Camp Fire evacuation shelters in Butte and Glenn counties. Norovirus is highly infectious, spreads quickly in congregate settings (*4*) through contaminated food and beverages and person-to-person contact, and can persist in the environment on surfaces or objects. The norovirus genotype GII.4, which caused this outbreak, is the most prevalent genotype in the United States and is associated with higher rates of hospitalization and mortality (*5*). Implementing effective illness surveillance and IPC early is essential to preventing norovirus transmission and associated severe illness.

The severity of the Camp Fire necessitated rapid shelter creation, but the massive infrastructure damage to roads and hospitals impaired baseline public health systems that normally help prevent illness, including access to medical care, cleaning and disinfection services, trash removal, personal protective equipment procurement, and surveillance and IPC support. For NGOs creating shelters rapidly, with limited access to surveillance and IPC resources, preventing norovirus transmission was challenging. Early in the response, local public health staff members and volunteers assisted with shelter medical staffing and surveillance; however, local resources were quickly exhausted. Even after state resources arrived, implementing surveillance and shelter assessment tools remained challenging because of limited Internet and printing services, and impaired communication among public health partners.

During this outbreak, rapid implementation of surveillance and IPC with adaptation based on local constraints was essential. With multiple government entities and NGOs involved, effective collaboration was necessary to institute standardized protocols for illness screening, isolation, and cleaning and disinfection with a bleach-based agent or an Environmental Protection Agency List G agent. In addition, extending surveillance and IPC efforts to include outdoor evacuees improved illness identification and medical service access, reduced risk for transmission, and promoted isolation practices that met IPC requirements and evacuee needs. Comprehensive, collaborative surveillance and IPC practices facilitated effective identification and management of ill persons to minimize norovirus transmission.

Summary

What is already known about this topic?

Norovirus infection, the leading cause of acute gastroenteritis (AGE) in the United States, is highly contagious and resistant to several disinfectants. Outbreaks are common in disaster evacuation shelters, given frequent close personal contact and challenges with infection prevention and control (IPC).

What is added by this report?

In California, during November 8–30, 2018, a total of 292 patients with AGE were identified among approximately 1,100 evacuees in Camp Fire evacuation shelters; 16 of 17 patient specimens were positive for norovirus genotype GII.4 Sydney [P16]. Shelter assessment revealed deficiencies in illness surveillance and IPC, which prompted public health intervention.

What are the implications for public health practice?

During a large-scale natural disaster, in a setting where immediate access to public health resources is limited, prioritizing effective illness surveillance and IPC at shelter initiation could improve AGE outbreak identification and control.

Total norovirus cases documented during this outbreak are likely an undercount of the true number of cases. Given the massive staffing needs during the response, few public health staff members were able to assist with early surveillance efforts. In addition, ill shelter staff members were not consistently identified because they were isolated off-site or became ill after deployment.

Given the increasing number of wildfires in the western United States (*6*), future events requiring large-scale sheltering are likely. Illness and outbreak prevention in shelters has been difficult during previous disaster relief efforts (*7*); in severe disasters affecting resource-constrained settings, it is particularly challenging to predict the unanticipated shelters created out of necessity and the duration of sheltering required. With the emergence of novel coronavirus (COVID-19) in 2020, and the substantial risk of infectious disease outbreaks in evacuation centers, expanding and implementing the lessons learned from the Camp Fire response on surveillance and IPC will be critical to prevent additional morbidity and mortality. Although disaster relief must address multiple urgent and competing needs, advanced planning by local, state, and federal public health partners, and NGOs to facilitate timely, effective shelter illness surveillance and IPC in both planned and unanticipated shelters is crucial to prevent, identify, and contain infectious disease outbreaks.

Acknowledgments

Evacuees from the Camp Fire wildfire; all volunteers for the wildfire response, and specifically James Watt, Gil Chavez, Susan Fanelli, Karen Smith, California Department of Public Health; Monica Soderstrom, Andrew Miller, Butte County Public Health Department; Emergency Medical Services Authority of California; Commissioned Corps of the U.S. Public Health Service.

Corresponding author: Ellora Karmarkar, ellora.karmarkar@cdph.ca.gov, 510-620-3446.

[1]Epidemic Intelligence Service, CDC; [2]California Department of Public Health; [3]Butte County Public Health Department, Chico, California; [4]Nevada County Public Health Department, Grass Valley, California; [5]Sutter County Health and Human Services—Public Health Branch, Yuba City, California; [6]Career Epidemiology Field Officer Program, CDC.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of possible conflicts of interest. No potential conflicts of interest were disclosed.

References

1. California Department of Forestry and Fire Protection. Camp Fire. Sacramento, CA: California Department of Forestry and Fire Protection; 2019. https://www.fire.ca.gov/incidents/2018/11/8/camp-fire/
2. US Census Bureau. QuickFacts: Butte County, California. Washington, DC: US Census Bureau; 2018. https://www.census.gov/quickfacts/buttecountycalifornia
3. CDC. Environmental health assessment form for disaster shelters. Atlanta, GA: US Department of Health and Human Services, CDC; 2018. https://emergency.cdc.gov/shelterassessment/index.asp
4. Robilotti E, Deresinski S, Pinsky BA. Norovirus. Clin Microbiol Rev 2015;28:134–64. https://doi.org/10.1128/CMR.00075-14
5. Burke RM, Shah MP, Wikswo ME, et al. The norovirus epidemiologic triad: predictors of severe outcomes in US norovirus outbreaks, 2009–2016. J Infect Dis 2019;219:1364–72. https://doi.org/10.1093/infdis/jiy569
6. Westerling AL, Hidalgo HG, Cayan DR, Swetnam TW. Warming and earlier spring increase western U.S. forest wildfire activity. Science 2006;313:940–3. https://doi.org/10.1126/science.1128834
7. Yee EL, Palacio H, Atmar RL, et al. Widespread outbreak of norovirus gastroenteritis among evacuees of Hurricane Katrina residing in a large "megashelter" in Houston, Texas: lessons learned for prevention. Clin Infect Dis 2007;44:1032–9. https://doi.org/10.1086/512195

Update on Extensively Drug-Resistant *Salmonella* Serotype Typhi Infections Among Travelers to or from Pakistan and Report of Ceftriaxone-Resistant *Salmonella* Serotype Typhi Infections Among Travelers to Iraq — United States, 2018–2019

Louise K. François Watkins, MD[1]; Alison Winstead, MD[1,2]; Grace D. Appiah, MD[1]; Cindy R. Friedman, MD[1]; Felicita Medalla, MD[1]; Michael J. Hughes, MPH[1,3]; Meseret G. Birhane, MPH[1]; Zachary D. Schneider, MPH[1,4]; Perrine Marcenac, PhD[1,2]; Samir S. Hanna, MD[5]; Gauri Godbole, MD[6]; Kelly A . Walblay, MPH[7]; Ashley E. Wiggington, MPH[8]; Molly Leeper, MPH[1]; Elizabeth H. Meservey[1,9]; Kaitlin A. Tagg, PhD[1,9]; Jessica C. Chen, PhD[1]; Abdinasir Abubakar, MD[10]; Faris Lami, PhD[11]; Asaad M. Asaad, MD[11]; Vickneswaran Sabaratnam, MPH[12]; Aamer Ikram, PhD[13]; Kristina M. Angelo, DO[14]; Allison Walker, PhD[14]; Eric Mintz, MD[1]

Ceftriaxone-resistant *Salmonella enterica* serotype Typhi (Typhi), the bacterium that causes typhoid fever, is a growing public health threat. Extensively drug-resistant (XDR) Typhi is resistant to ceftriaxone and other antibiotics used for treatment, including ampicillin, chloramphenicol, ciprofloxacin, and trimethoprim-sulfamethoxazole (*1*). In March 2018, CDC began enhanced surveillance for ceftriaxone-resistant Typhi in response to an ongoing outbreak of XDR typhoid fever in Pakistan. CDC had previously reported the first five cases of XDR Typhi in the United States among patients who had spent time in Pakistan (*2*). These illnesses represented the first cases of ceftriaxone-resistant Typhi documented in the United States (*3*). This report provides an update on U.S. cases of XDR typhoid fever linked to Pakistan and describes a new, unrelated cluster of ceftriaxone-resistant Typhi infections linked to Iraq. Travelers to areas with endemic Typhi should receive typhoid vaccination before traveling and adhere to safe food and water precautions (*4*). Treatment of patients with typhoid fever should be guided by antimicrobial susceptibility testing whenever possible (*5*), and clinicians should consider travel history when selecting empiric therapy.

Typhi is transmitted through the fecal-oral route, usually by contaminated water or food. The incubation period of typhoid fever is typically 6–30 days. Untreated, it has a mortality rate of 12%–30% (*3*,*4*). Ceftriaxone and ciprofloxacin are first-choice antibiotics, with ampicillin, azithromycin, or trimethoprim-sulfamethoxazole being alternative options (*5*). In the United States, typhoid fever is a notifiable disease, and approximately 350 culture-confirmed cases are submitted to CDC annually. Local and state public health departments send epidemiologic information from culture-confirmed cases to CDC's National Typhoid and Paratyphoid Fever Surveillance system and submit isolates to CDC's National Antimicrobial Resistance Monitoring System (NARMS) laboratory for antimicrobial susceptibility testing. Typhi isolates undergo whole genome sequencing (WGS) at public health laboratories when resources are available. WGS data are submitted to CDC's PulseNet laboratory network and uploaded to the National Center for Biotechnology Information (NCBI).* WGS can be used to determine relatedness of isolates and to identify genes and mutations that confer resistance.

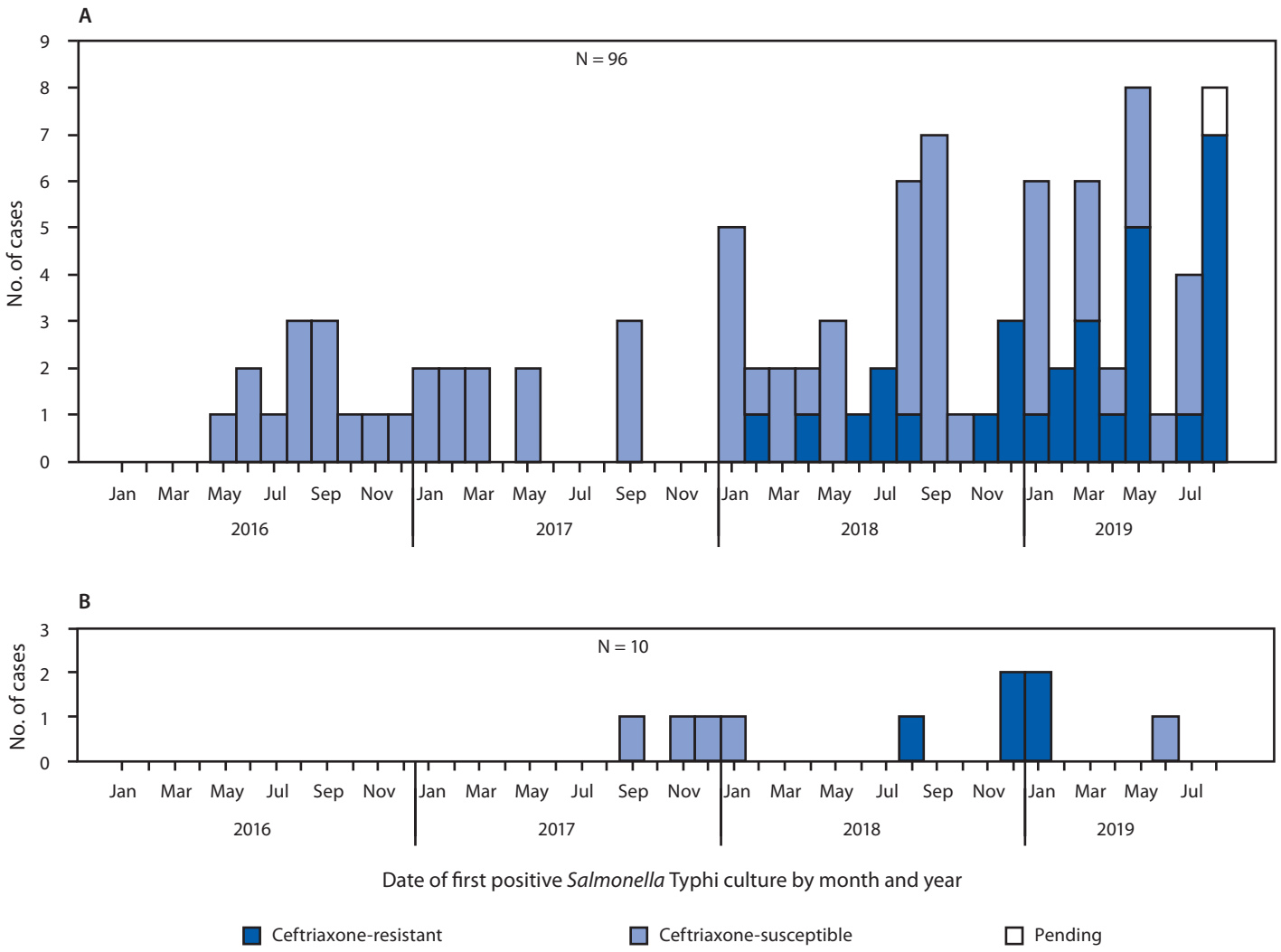
After XDR Typhi was reported in Pakistan, CDC initiated enhanced surveillance for ceftriaxone-resistant Typhi. CDC requested that health departments notify CDC immediately when a patient with typhoid fever reported recent travel to Pakistan. In addition, health departments used a supplementary interview form to collect additional information about travel and exposures for patients or household contacts who had been in Pakistan during the month before illness onset. The corresponding isolates underwent expedited antimicrobial susceptibility testing through NARMS. Finally, CDC implemented alert systems to automatically notify agency epidemiologists whenever a ceftriaxone-resistant Typhi isolate was identified by NARMS or reported to NCBI.

During January 1, 2016–August 31, 2019, CDC identified 96 Typhi infections among U.S. travelers to or from Pakistan (Figure 1). Among these, 30 (31%) isolates were identified as XDR by antimicrobial susceptibility testing (28) or WGS (two); isolates were resistant to ceftriaxone, ampicillin, chloramphenicol, ciprofloxacin, nalidixic acid, streptomycin, sulfisoxazole, and trimethoprim-sulfamethoxazole (Figure 2). The median age of patients with XDR typhoid fever was 11.5 years (range = 1–41 years), 53% (16 of 30) were male, 93% (26 of 28) were hospitalized, and none of 24 for whom information was available reported typhoid vaccination within 5 years of travel (Table). Among 20 patients with information on travel within Pakistan, 12 (60%) traveled to Karachi or other parts of Sindh province, the region of the reported XDR epidemic (*1*); the other eight (40%) patients did not report travel to Sindh but had visited Punjab province.

In November 2018, CDC detected a ceftriaxone-resistant Typhi isolate with a novel resistance pattern in a patient who reported travel to Iraq in the 4 weeks preceding illness onset. As were the Pakistan XDR isolates, this isolate (PNUSAS051326)

* https://www.ncbi.nlm.nih.gov.

FIGURE 1. Cases of culture-confirmed typhoid fever linked to travel to or from Pakistan (A) or Iraq* (B), by ceftriaxone susceptibility status and culture date (month/year) — United States,† January 1, 2016–August 31, 2019



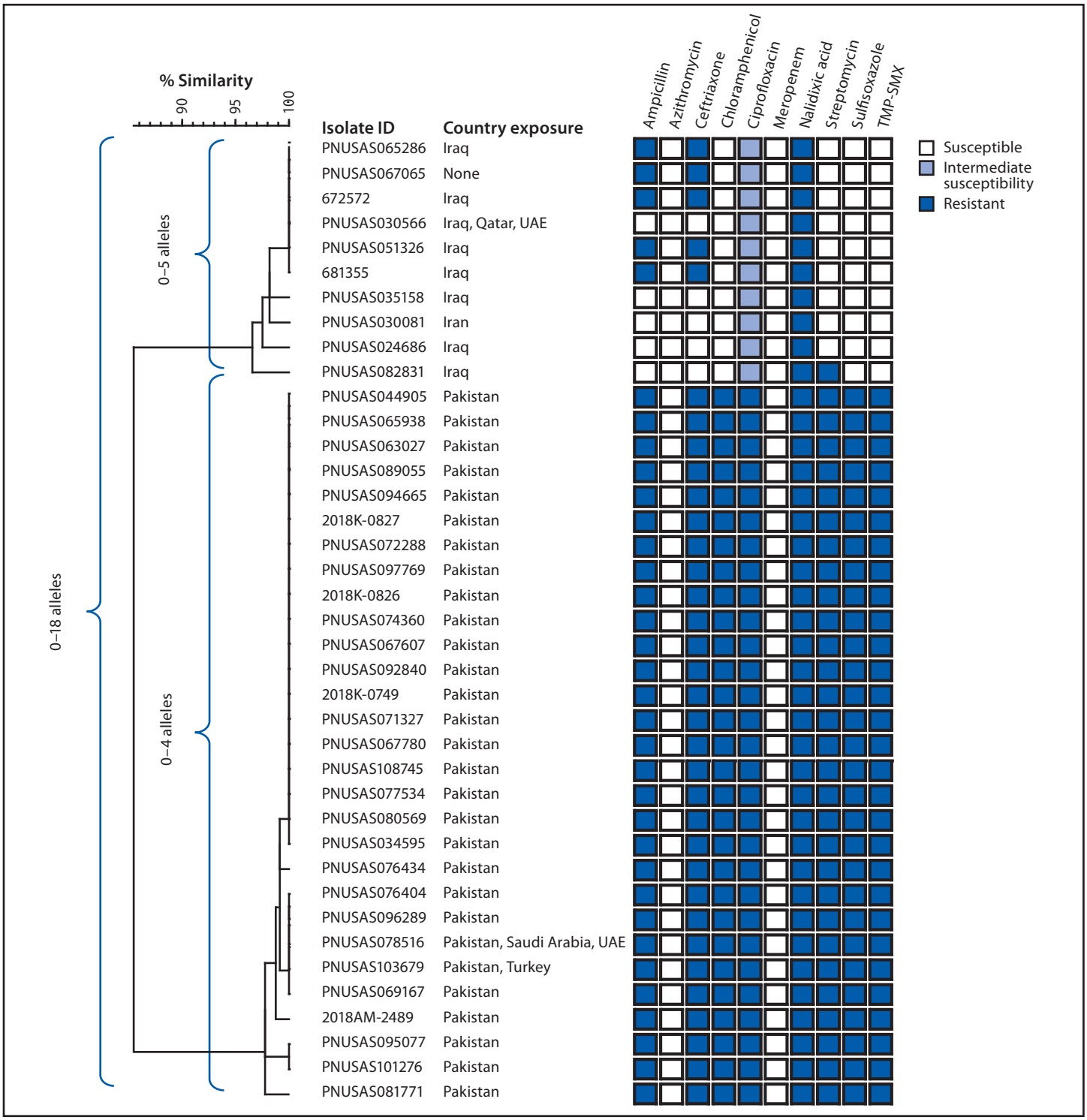
* The patient with diagnosis in November 2017 traveled to Iran only.
† Two patients whose cases were diagnosed in January 2019 were residents of the United Kingdom who became ill after travel to Iraq (panel B).

(Figure 2) was resistant to ceftriaxone, ampicillin, and nalidixic acid, but it showed intermediate susceptibility to ciprofloxacin and full susceptibility to other antibiotics, including chloramphenicol and trimethoprim-sulfamethoxazole.

Using information reported to NCBI, CDC identified nine additional isolates that were highly related to the isolate from the traveler to Iraq, corresponding to seven additional U.S. patients and two from the United Kingdom. Of these nine patients, seven (five U.S. residents and both U.K. patients) had also traveled to Iraq. One patient was a child who did not travel herself, but her father (who was asymptomatic) had returned from Iraq within the month before her illness began. One patient reported travel to Iran only. Of the 10 patients, nine were adults (median age = 43 years; range = 3–75 years), five were male, and none of six for whom information was available reported pretravel vaccination for typhoid. None reported travel to Pakistan. Specimen collection dates were from September 2017 through June 2019 (Figure 1); the five isolates clustered from August 2018 through January 2019 shared the same antibiotic resistance pattern, whereas the earlier and later isolates lacked resistance to ceftriaxone and ampicillin. No other U.S. cases of typhoid fever related to travel to Iran or Iraq have been reported to CDC since January 1, 2016.

Public health officials in Iraq noted an increase in cases of typhoid fever in the fall of 2018, which coincided with Arba'een, an annual religious pilgrimage to the city of Karbala, Iraq. Arba'een has been described as the world's largest annual

FIGURE 2. Core genome multilocus sequence typing (cgMLST) phylogenetic tree* of 39† *Salmonella* Typhi isolates from two strains with ceftriaxone resistance among persons with travel to Iran, Iraq,§ and Pakistan — United States and United Kingdom,¶ 2017–2019



Abbreviations: TMP-SMX = trimethoprim-sulfamethoxazole; UAE = United Arab Emirates.

* The tree was constructed using BioNumerics (version 7.6; Applied Maths). The National Center for Biotechnology Information strain identifier and country exposure(s) during the patient's incubation period are shown. Shaded boxes indicate resistance patterns determined by antimicrobial susceptibility testing (n = 35) or predicted resistance from whole genome sequencing (n = 4, with isolate IDs 672572, 681355, PNUSAS095077, and PNUSAS101276).

† One ceftriaxone-resistant Typhi isolate from a patient with travel to Pakistan was not included in this figure because the isolate did not undergo whole genome sequencing.

§ One isolate (ID PNUSAS067065) was cultured from a patient who did not travel, but whose asymptomatic father returned from Iraq in the 30 days before her symptom onset.

¶ Isolates with IDs 672572 and 681355 were cultured from residents of the United Kingdom.

TABLE. Characteristics of patients (n=30) with extensively drug-resistant typhoid fever — United States, 2018–2019

Characteristic (no. with available information)	No (%)
Sex (30)	
Male	16 (53)
Age group (yrs) (30)	
<2	1 (3)
2–5	6 (20)
6–11	8 (27)
12–17	5 (17)
18–41	10 (33)
Purpose of travel (26)	
Visiting friends and relatives	22 (85)
Other	4 (15)
Destination within Pakistan (20)	
Sindh province only	9 (45)
Sindh province and Punjab province	2 (10)
Sindh province, Punjab province, and Islamabad	1 (5)
Punjab province only	7 (35)
Punjab province and Islamabad	1 (5)
Pretravel vaccination (24)	**0 (0)**
Hospitalization (28)	**26 (93)**
Median duration of stay, days (range)	7.5 (2–19)
Intensive care unit admission (19)	**3 (16)**

Summary

What is already known about this topic?

Before 2018, no ceftriaxone-resistant *Salmonella* Typhi cases had been identified in the United States. Extensively drug-resistant *Salmonella* Typhi, susceptible only to azithromycin and carbapenems, has caused a typhoid fever outbreak in Pakistan since 2016.

What is added by this report?

During February 2018–August 2019, 33 cases of ceftriaxone-resistant *Salmonella* Typhi were detected in the United States. Whole genome sequencing of isolates identified two distinct clusters, associated with travel to Pakistan (30 cases) and Iraq (three).

What are the implications for public health practice?

Vaccination and food and water precautions can help prevent typhoid fever. Clinicians and public health officials should remain vigilant for ceftriaxone-resistant Typhi in patients who have traveled to Pakistan, Iraq, or neighboring countries.

gathering (10–20 million participants). One of the British patients reported traveling to Iraq to attend Arba'een (*6*).

Genomic analysis showed that the strain of Typhi associated with travel to Iran and Iraq was genetically distinct from the XDR strain associated with travel to Pakistan (Figure 2). In both strains, ceftriaxone resistance was due to an extended-spectrum beta-lactamase resistance gene ($bla_{\text{CTX-M-15}}$) carried by an IncY type plasmid. However, the plasmid found in the Pakistan strain (all travelers) and the plasmid found in the Iraq strain (five of 10 travelers) were not closely related.

As of August 31, 2019, all U.S. patients with ceftriaxone-resistant typhoid fever were linked to either Iraq or Pakistan. Ceftriaxone-resistant Typhi isolates in the United States during this period were susceptible to azithromycin and meropenem.

Discussion

During February 2018–August 2019, CDC identified 33 ceftriaxone-resistant Typhi isolates from U.S. patients; no such isolates had been identified before 2018. Thirty isolates were from cases of XDR typhoid fever linked to travel to Pakistan; notably, these cases have occurred with increasing frequency and reflect the ongoing outbreak in Sindh province, with approximately 10,000 cases reported as of August 2019 (*7*). In November 2019, approximately 9.4 million children aged 9 months–15 years in Sindh province were vaccinated against typhoid fever with the typhoid conjugate vaccine prequalified by the World Health Organization (*8*). In August 2018, CDC identified a second strain of ceftriaxone-resistant Typhi, this one related to travel to Iraq. Isolates linked to travel to Iraq appear genetically distinct from isolates linked to travel to Pakistan, suggesting that the emergence of ceftriaxone resistance among these two strains was unrelated. In both strains, the ceftriaxone resistance is plasmid-mediated and has the potential to spread to other bacteria.

Eight U.S. patients with XDR Typhi linked to travel to Pakistan did not travel to Sindh province, suggesting the outbreak is more widespread in Pakistan than has been previously reported (*1*). Public health officials and clinicians should remain vigilant for cases of ceftriaxone-resistant Typhi in patients who have traveled to countries neighboring Iraq and Pakistan and of strains of Typhi with more extensive resistance, particularly to azithromycin, because this has been reported from some parts of South Asia (*9*). These cases also highlight the public health risks associated with mass gatherings such as the Arba'een pilgrimage. Public health authorities should prepare for mass gatherings by ensuring safe drinking water and food and adequate infrastructure for proper sanitation and hygiene (*10*).

The findings in this report are subject to at least three limitations. First, some cases of ceftriaxone-resistant Typhi that occurred before August 31, 2019, might have been missed because some health departments might have delayed both case reporting and isolate submission for susceptibility testing until the end of the 2019 calendar year. Second, detailed clinical or travel histories were not obtained for all patients because some patients did not respond to requests from the health department for more information. Finally, most clinical and travel information was obtained by patient self-report and not independently verified.

Currently, most Typhi infections diagnosed in the United States are not susceptible to fluoroquinolones, such as ciprofloxacin, and the prevalence of resistance is >10% for ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole (*3*). Therefore, ceftriaxone has become increasingly important for empiric treatment (*5*), and the emergence of ceftriaxone resistance in Typhi strains that are not susceptible to ciprofloxacin presents a significant treatment challenge. Clinicians should request antimicrobial susceptibility testing for all Typhi isolates and tailor patient treatment accordingly. All patients should be asked about travel, and special consideration should be given to empiric treatment for patients who have recently returned from Iraq or Pakistan. For XDR Typhi, azithromycin may be used for uncomplicated cases, and carbapenems (e.g., meropenem) may be used for severe illness (*2*). For travelers returning from Iraq, trimethoprim-sulfamethoxazole remains an alternative.

The emergence of ceftriaxone-resistant Typhi highlights the need for effective prevention measures. Notably, none of the patients for whom vaccine history was available had been vaccinated before travel. Clinicians should advise patients traveling to areas with endemic Typhi to receive pretravel typhoid vaccination and to practice safe food and water precautions (*4*). Additional information is available at https://www.cdc.gov/typhoid-fever/prevention.html (prevention measures for travelers), https://www.cdc.gov/typhoid-fever/resources.html, (resources for the public, public health officials, and clinicians) and https://wwwnc.cdc.gov/travel/diseases/typhoid (disease and travel-specific information).

Acknowledgments

State and local public health officials from California, Florida, Georgia, Illinois, Louisiana, Maryland, Michigan, Missouri, Montana, North Carolina, New Jersey, New York, Pennsylvania, Tennessee, Texas, Virginia, Washington, Wisconsin, New York City Department of Health and Mental Hygiene, and Houston Health Department; Parvin Arjmandi, Jonathan Kolsin, Bethany LeClair; World Health Organization Regional Office for the Eastern Mediterranean; National Institute of Health, Islamabad, Pakistan; Iraq Ministry of Health, Baghdad, Iraq; Public Health England, London, United Kingdom; CDC-Pakistan; Lauren Ahart, Jennifer Collins, Layne Dorough, Division of Foodborne, Waterborne, and Environmental Diseases, National Center for Emerging and Zoonotic Infectious Diseases, CDC.

Corresponding author: Louise K. François Watkins, lfrancoiswatkins@cdc.gov, 404-639-4755.

[1]Division of Foodborne, Waterborne, and Environmental Diseases, National Center for Emerging and Zoonotic Infectious Diseases, CDC; [2]Epidemic Intelligence Service, CDC; [3]Atlanta Research & Education Foundation, Atlanta, Georgia; [4]Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee; [5]Tennessee Department of Health; [6]Gastrointestinal Bacteria Reference Laboratory, Public Health England, London, United Kingdom; [7]Illinois Department of Public Health; [8]Missouri Department of Health and Senior Services; [9]WDS, Inc., Suwanee, Georgia; [10]World Health Organization Regional Office for the Eastern Mediterranean, Cairo, Egypt; [11]Iraq Ministry of Health, Baghdad, Iraq; [12]World Health Organization, Baghdad, Iraq; [13]National Institute of Health, Islamabad, Pakistan; [14]Division of Global Migration and Quarantine, National Center for Emerging and Zoonotic Infectious Diseases, CDC.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. Qamar FN, Yousafzai MT, Khalid M, et al. Outbreak investigation of ceftriaxone-resistant *Salmonella enterica* serotype Typhi and its risk factors among the general population in Hyderabad, Pakistan: a matched case-control study. Lancet Infect Dis 2018;18:1368–76. https://doi.org/10.1016/S1473-3099(18)30483-3
2. Chatham-Stephens K, Medalla F, Hughes M, et al. Emergence of extensively drug-resistant *Salmonella* Typhi infections among travelers to or from Pakistan—United States, 2016–2018. MMWR Morb Mortal Wkly Rep 2019;68:11–3. https://doi.org/10.15585/mmwr.mm6801a3
3. CDC. NARMS now: human data. Atlanta, GA: US Department of Health and Human Services, CDC; 2020. https://wwwn.cdc.gov/narmsnow
4. Appiah GD, Hughes MJ, Chatham-Stephens K. Typhoid and paratyphoid fever. In: CDC yellow book 2020: health information for international travel. New York: Oxford University Press; 2019. https://wwwnc.cdc.gov/travel/page/yellowbook-home
5. Shane AL, Mody RK, Crump JA, et al. 2017 Infectious Diseases Society of America clinical practice guidelines for the diagnosis and management of infectious diarrhea. Clin Infect Dis 2017;65:e45–80. https://doi.org/10.1093/cid/cix669
6. Godbole G, McCann N, Jones SM, Dallman TJ, Brown M. Ceftriaxone-resistant *Salmonella* Typhi in a traveller returning from a mass gathering in Iraq. Lancet Infect Dis 2019;19:467. https://doi.org/10.1016/S1473-3099(19)30176-8
7. World Health Organization Regional Office for the Eastern Mediterranean. Drug resistant *Salmonella* infections in Pakistan: update. Weekly Epidemiologic Monitor 2019;12. https://reliefweb.int/sites/reliefweb.int/files/resources/Epi_Monitor_2019_12_34.pdf
8. World Health Organization Regional Office for the Eastern Mediterranean. Pakistan: more than 9.4 million children vaccinated against typhoid fever in Sindh. Cairo, Egypt: World Health Organization Regional Office for the Eastern Mediterranean; 2019. http://www.emro.who.int/pak/pakistan-news/more-than-94-children-vaccinated-with-typhoid-conjugate-vaccine-in-sindh.html
9. Sharma P, Kumari B, Dahiya S, et al. Azithromycin resistance mechanisms in typhoidal salmonellae in India: a 25 years analysis. Indian J Med Res 2019;149:404–11. https://doi.org/10.4103/ijmr.IJMR_1302_17
10. Memish ZA, Steffen R, White P, et al. Mass gatherings medicine: public health issues arising from mass gathering religious and sporting events. Lancet 2019;393:2073–84. https://doi.org/10.1016/S0140-6736(19)30501-X

Surveillance to Track Progress Toward Polio Eradication — Worldwide, 2018–2019

Jacquelyn S. Lickness, MPH[1]; Tracie Gardner, PhD[2]; Ousmane M. Diop, PhD[2]; Smita Chavan, MS[1]; Jaume Jorba, PhD[3]; Jamal Ahmed, MD[2]; Nicksy Gumede, PhD[4]; Ticha Johnson, MD[4]; Obaid Butt, MD[5]; Humayun Asghar, MD[5]; Eugene Saxentoff, PhD[6]; Varja Grabovac, MSc[7]; Tigran Avagyan, MD[7]; Sudhir Joshi, MPH[8]; Gloria Rey-Benito, MSc[9]; Jane Iber, MSc[3]; Elizabeth Henderson[3]; Steven G.F. Wassilak, MD[1]; Abhijeet Anand, MBBS[1]

Since the Global Polio Eradication Initiative (GPEI) was launched in 1988, the number of polio cases worldwide has declined approximately 99.99%; only two countries (Afghanistan and Pakistan) have never interrupted wild poliovirus (WPV) transmission (*1*). The primary means of detecting poliovirus circulation is through surveillance for acute flaccid paralysis (AFP) among children aged <15 years with testing of stool specimens for WPV and vaccine-derived polioviruses (VDPVs) (genetically reverted strains of the vaccine virus that regain neurovirulence) in World Health Organization (WHO)–accredited laboratories (*2*,*3*). In many locations, AFP surveillance is supplemented by environmental surveillance, the regular collection and testing of sewage to provide awareness of the extent and duration of poliovirus circulation (*3*). This report presents 2018–2019 poliovirus surveillance data, focusing on 40 priority countries* with WPV or VDPV outbreaks or at high risk for importation because of their proximity to a country with an outbreak. The number of priority countries rose from 31 in 2018 to 40 in 2019 because of a substantial increase in the number of VDPV outbreaks† (*2*,*4*). In areas with low poliovirus immunity, VDPVs can circulate in the community and cause outbreaks of paralysis; these are known as circulating vaccine derived polioviruses (cVDPVs) (*4*). In 2019, only 25 (63%) of the 40 designated priority countries met AFP surveillance indicators nationally; subnational surveillance performance varied widely and indicated focal weaknesses. High quality, sensitive surveillance is important to ensure timely detection and response to cVDPV and WPV transmission.

Acute Flaccid Paralysis Surveillance

Two primary surveillance performance indicators assess AFP surveillance quality. The first is the nonpolio AFP (NPAFP) rate§ (the number of NPAFP cases per 100,000 children aged <15 years per year); an NPAFP rate ≥2 is considered sufficiently sensitive to detect circulating poliovirus. The second is the collection of adequate stool specimens from AFP patients (i.e., two stool specimens collected ≥24 hours apart and within 14 days of paralysis onset) and arrival of these specimens at a WHO-accredited laboratory by reverse cold chain (storing and transporting samples at recommended temperatures from the point of collection to the laboratory) and in good condition (i.e., without leakage or desiccation) from ≥80% of persons with AFP, which ensures adequate sensitivity and specificity to track poliovirus circulation (*3*).

Among the 47 countries in the WHO African Region (AFR), the number of priority countries increased from 18 (38%) in 2018 to 30 (64%) in 2019 because of the increase in the number of VDPV outbreaks (*2*,*4*). To describe the previous 2 years' performance for this year's priority countries, surveillance performance was assessed for 2018 and 2019 for the 30 2019 priority countries in AFR (Table 1). In 2018, cVDPV type 2 (cVDPV2) cases or environmental surveillance isolations were detected in five countries (Democratic Republic of the Congo [DRC], Kenya, Mozambique, Niger, and Nigeria) and, in 2019, in 14 countries (Angola, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, DRC, Ethiopia, Ghana, Niger, Nigeria, Togo, and Zambia). In 2018 and 2019, both the NPAFP rate and adequate stool collection AFP surveillance performance indicators were met nationally in 27 (90%) and 20 (67%) of the 30 2019 priority countries, respectively (Table 1). Numerous subnational pockets of low surveillance performance were identified during 2018–2019 (Table 1) (Figure). September 2019 marked 3 years since the last reported WPV1 isolation in AFR (in Borno, Nigeria); during this period, populations living within

* 2019 priority countries: *African Region:* Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, Ghana, Guinea, Kenya, Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, South Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe; *Eastern Mediterranean Region*: Afghanistan, Djibouti, Pakistan, Somalia, and Sudan; *South-East Asia Region*: Burma (Myanmar) and Indonesia; *Western Pacific Region*: Malaysia, Papua New Guinea, and Philippines; 2018 priority countries; *African Region:* Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Democratic Republic of the Congo, Equatorial Guinea, Ethiopia, Guinea, Guinea Bissau, Kenya, Liberia, Mali, Mozambique, Niger, Nigeria, Sierra Leone, and South Sudan; *Eastern Mediterranean Region:* Afghanistan, Djibouti, Iraq, Jordan, Lebanon, Libya, Pakistan, Somalia, Sudan, Syria, and Yemen; *South-East Asia Region:* Indonesia; *Western Pacific Region:* Papua New Guinea.

† Countries were selected for the previous 2017–2018 MMWR report according to the Global Polio Surveillance Action Plan high-priority country list; countries for this report (2018–2019) were selected according to whether they had endemic transmission, had a VDPV outbreak, or were in geographic proximity to an outbreak in Africa.

§ Per 100,000 children aged <15 years per year.

TABLE 1. National and subnational acute flaccid paralysis (AFP) surveillance performance indicators and number of confirmed wild poliovirus (WPV) and circulating vaccine-derived poliovirus (cVDPV) cases, by country — 40 priority countries, World Health Organization (WHO) African, Eastern Mediterranean, South-East Asia, and Western Pacific regions, 2018–2019

Year/WHO region/Country	No. of AFP cases (all ages)	Regional/ National NPAFP rate†	Subnational areas with NPAFP rate ≥2 (%)§	Regional or national AFP cases with adequate specimens (%)¶	Subnational areas with ≥80% adequate specimens (%)	Population living in areas meeting both indicators (%)**	No. of confirmed WPV cases*	No. of confirmed cVDPV cases*,††
2018								
African Region	**22,620**	**5.6**	**N/A**	**89.3**	**N/A**	**N/A**	—§§	**65**
Angola	330	2.3	77.8	92.7	94.4	58.8	—	—
Benin	209	4.3	100.0	90.4	100.0	100.0	—	—
Botswana	19	2.6	81.8	100.0	100.0	62.2	—	—
Burkina Faso	359	4.0	100.0	85.2	76.9	83.9	—	—
Burundi	122	2.4	37.5	90.2	81.3	27.3	—	—
Cameroon	777	7.2	90.0	83.5	80.0	71.9	—	—
Central African Republic	134	6.6	85.7	67.2	14.3	0.0	—	—
Chad	650	9.0	100.0	90.5	81.8	93.8	—	—
Congo	167	7.2	100.0	88.0	90.9	97.5	—	—
Côte d'Ivoire	374	3.5	94.1	80.2	47.1	38.8	—	—
Democratic Republic of the Congo	2,743	6.6	85.2	77.3	55.6	53.0	—	20
Eritrea	114	5.3	100.0	95.6	80.0	96.9	—	—
Ethiopia	1,079	2.5	72.7	83.1	54.5	51.2	—	—
Ghana	510	4.3	90.0	87.5	90.0	75.6	—	—
Guinea	232	4.2	100.0	88.8	87.5	81.6	—	—
Kenya	680	3.3	72.3	87.2	72.3	56.1	—	—
Liberia	72	3.6	100.0	84.7	66.7	81.3	—	—
Malawi	210	2.4	100.0	88.1	100.0	100.0	—	—
Mali	292	3.2	100.0	87.0	77.8	96.2	—	—
Mozambique	463	3.4	100.0	88.1	81.8	86.6	—	1
Namibia	25	1.8	66.7	80.0	66.7	43.3	—	—
Niger	973	8.6	100.0	81.0	75.0	81.1	—	10
Nigeria	9,375	10.9	100.0	95.3	100.0	100.0	—	34
Rwanda	140	2.8	80.0	87.1	100.0	89.2	—	—
South Sudan	447	8.3	100.0	83.0	60.0	62.9	—	—
Tanzania	875	3.3	100.0	97.8	100.0	100.0	—	—
Togo	144	4.4	100.0	88.2	100.0	100.0	—	—
Uganda	712	3.3	62.8	90.4	88.4	54.8	—	—
Zambia	198	2.4	66.7	84.3	66.7	37.1	—	—
Zimbabwe	195	2.7	100.0	93.8	100.0	100.0	—	—
Eastern Mediterranean Region	**16,522**	**15.1**	**N/A**	**88.6**	**N/A**	**N/A**	**33**	**12**
Afghanistan	3,364	21.6	100.0	93.8	97.1	98.4	21	—
Djibouti	0	0.0	0.0	0.0	0.0	0.0	—	—
Pakistan	12,231	17.5	100.0	86.6	87.5	99.2	12	—
Somalia	351	4.8	100.0	97.7	100.0	100.0	—	12
Sudan	576	3.4	100.0	97.4	100.0	100.0	—	—
South-East Asia Region	2,055	2.4	N/A	83.4	N/A	N/A	—	1
Burma (Myanmar)¶¶	333	2.4	76.5	94.3	100.0	68.6	—	—
Indonesia	1,722	2.4	75.0	81.3	53.1	52.8	—	1
Western Pacific Region	783	1.7	N/A	58.5	N/A	N/A	—	26
Malaysia	170	2.2	42.9	79.4	57.1	23.4	—	—
Papua New Guinea	285	7.9	95.5	43.9	13.6	7.6	—	26
Philippines	328	1.0	0.0	60.4	0.0	0.0	—	—

See table footnotes on the next page.

security-compromised areas in Nigeria decreased and community-based surveillance and specimen collection increased (*5*).

Among the 21 countries in the WHO Eastern Mediterranean Region (EMR), the number of priority countries decreased from 11 (52%) in 2018 to five (24%) in 2019. Surveillance performance was assessed for the five 2019 priority countries in EMR (Afghanistan, Djibouti, Pakistan, Somalia, and Sudan) for 2018 and 2019 (Table 1). From 2018 to 2019, the number of WPV1 cases increased from 21 to 29 in Afghanistan (38% increase) and from 12 to 147 in Pakistan (1,125% increase). In 2019, 22 cVDPV2 cases were also reported in Pakistan (Table 1). In Somalia, 12 cVDPV cases (type 2 and 3) were reported in 2018 (including one coinfection with types 2 and 3), and three cVDPV2 cases were reported in 2019. Four of the five EMR priority countries met both surveillance indicators in 2018 and 2019; in Djibouti only

TABLE 1. (*Continued*) National and subnational acute flaccid paralysis (AFP) surveillance performance indicators and number of confirmed wild poliovirus (WPV) and circulating vaccine-derived poliovirus (cVDPV) cases, by country — 40 priority countries, World Health Organization (WHO) African, Eastern Mediterranean, South-East Asia, and Western Pacific regions, 2018–2019

Year/WHO region/Country	No. of AFP cases (all ages)	Regional/ National NPAFP rate†	Subnational areas with NPAFP rate ≥2 (%)§	Regional or national AFP cases with adequate specimens (%)¶	Subnational areas with ≥80% adequate specimens (%)	Population living in areas meeting both indicators (%)**	No. of confirmed WPV cases*	No. of confirmed cVDPV cases*,††
2019								
African Region	**22,329**	**5.4**	**N/A**	**84.2**	**N/A**	**N/A**	**—**	**287**
Angola	603	3.3	77.8	71.8	27.8	6.1	—	113
Benin	310	6.1	100.0	90.6	84.6	86.5	—	8
Botswana	27	3.1	86.7	66.7	46.7	32.0	—	—
Burkina Faso	374	4.1	43.8	82.4	81.3	34.0	—	1
Burundi	98	1.9	33.3	93.9	100.0	35.1	—	—
Cameroon	613	5.7	80.0	79.8	50.0	35.9	—	—
Central African Republic	230	8.3	100.0	51.7	0.0	0.0	—	21
Chad	820	11.0	100.0	82.9	59.1	68.1	—	5
Congo	195	8.1	100.0	81.0	58.3	61.9	—	—
Côte d'Ivoire	421	3.9	100.0	77.7	45.0	42.8	—	—
Democratic Republic of the Congo	3,816	9.0	92.6	70.6	7.4	7.2	—	85
Eritrea	110	5.0	100.0	86.4	60.0	47.2	—	—
Ethiopia	1,223	2.8	91.7	85.8	83.3	79.7	—	13
Ghana	663	5.5	100.0	86.6	87.5	94.5	—	14
Guinea	233	4.1	100.0	86.7	62.5	59.6	—	—
Kenya	560	2.6	72.3	92.9	78.7	66.9	—	—
Liberia	70	3.3	86.7	90.0	80.0	81.7	—	—
Malawi	189	2.1	66.7	89.4	100.0	56.0	—	—
Mali	301	3.2	90.9	82.1	63.6	77.8	—	—
Mozambique	510	3.6	100.0	72.5	27.3	31.5	—	—
Namibia	27	2.5	66.7	81.5	75.0	32.9	—	—
Niger	906	7.8	100.0	67.7	0.0	0.0	—	1
Nigeria	7,509	8.5	100.0	94.1	100.0	100.0	—	18
Rwanda	125	2.4	80.0	89.6	100.0	89.2	—	—
South Sudan	399	7.2	100.0	89.7	90.0	84.0	—	—
Tanzania	856	3.1	96.8	91.8	100.0	94.1	—	—
Togo	164	4.5	100.0	68.9	50.0	52.2	—	6
Uganda	580	2.7	86.7	89.7	93.3	77.4	—	—
Zambia	232	2.8	70.0	81.9	70.0	36.8	—	2
Zimbabwe	165	2.2	90.0	83.6	60.0	57.2	—	—
Eastern Mediterranean Region	**19,945**	**17.8**	**N/A**	**88.4**	**N/A**	**N/A**	**176**	**25**
Afghanistan	3,768	23.9	100.0	94.1	100.0	100.0	29	—
Djibouti	5	1.7	50.0	80.0	50.0	10.6	—	—
Pakistan	15,203	21.2	100.0	86.5	100.0	100.0	147	22
Somalia	361	5.0	100.0	95.6	100.0	100.0	—	3
Sudan	608	3.6	100.0	96.4	100.0	100.0	—	—
South-East Asia Region	2,210	2.6	N/A	80.5	N/A	N/A	—	6
Burma (Myanmar)¶¶	418	2.9	88.2	90.0	88.2	78.7	—	6
Indonesia	1,792	2.5	72.7	78.3	54.5	59.5	—	—
Western Pacific Region	1,279	2.8	N/A	55.4	N/A	N/A	—	18
Malaysia	194	2.5	78.6	74.7	50.0	36.2	—	3
Papua New Guinea	213	7.0	94.4	76.5	50.0	43.6	—	—
Philippines	872	2.5	12.5	46.0	0.0	0.0	—	15

Abbreviations: N/A = not applicable; NPAFP = nonpolio AFP.

* Data as of April 2, 2020.

† Per 100,000 persons aged <15 years per year.

§ For all subnational areas regardless of population size.

¶ Standard WHO target is adequate stool specimen collection from ≥80% of AFP cases, assessed by timeliness and condition. For this analysis, timeliness was defined as two specimens collected ≥24 hours apart (≥1 calendar day in this data set), both within 14 days of paralysis onset. Good condition was defined as arrival of specimens in a WHO-accredited laboratory with reverse cold chain maintained and without leakage or desiccation.

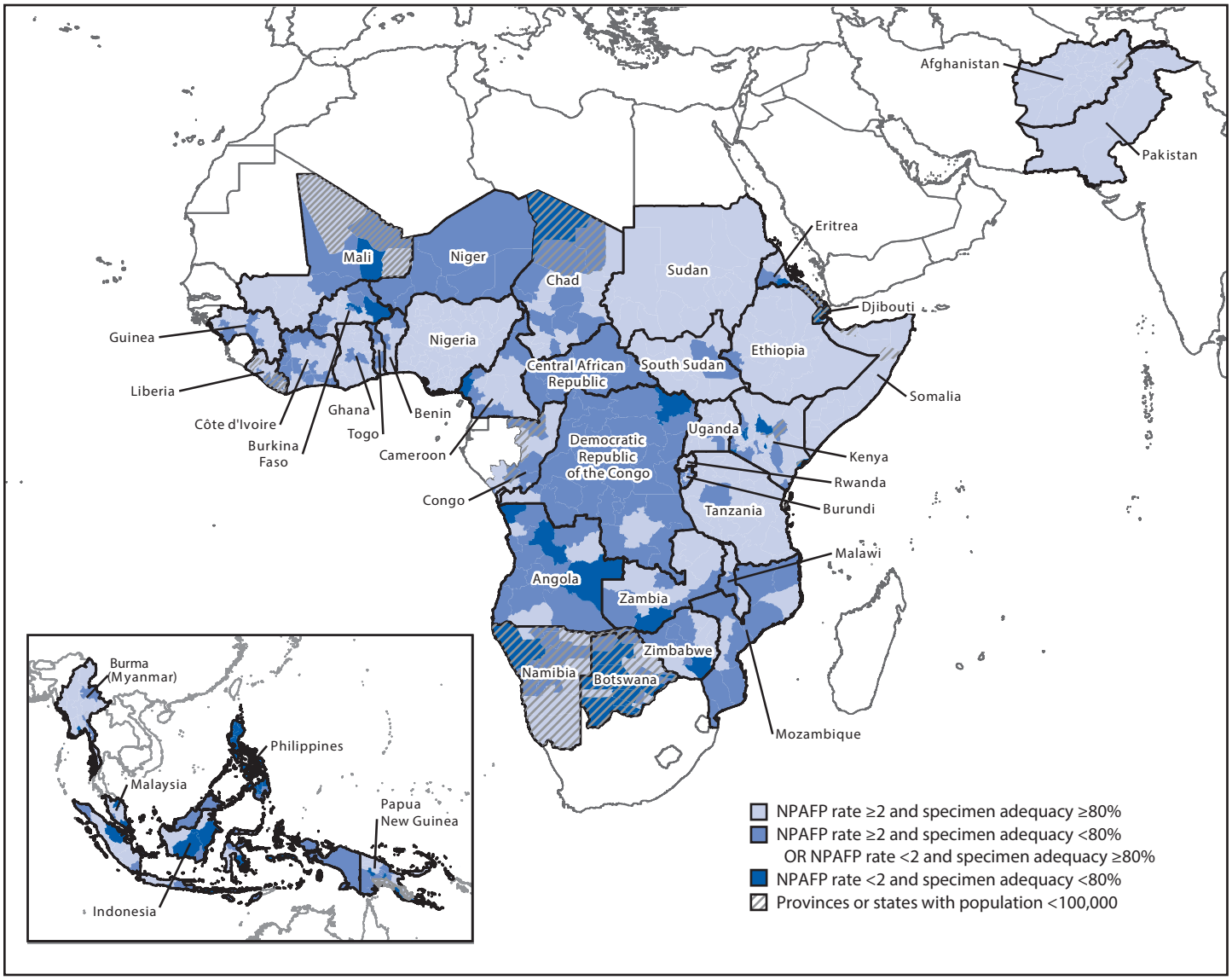
** Percentage of the country's population living in subnational areas that met both surveillance indicators (NPAFP rates ≥2 per 100,000 persons aged <15 years per year and ≥80% of AFP cases with adequate specimens).

†† cVDPV was associated with at least one case of AFP with evidence of community transmission and genetically linked. Guidelines for classification of cVDPV can be found at http://polioeradication.org/wp-content/uploads/2016/09/Reporting-and-Classification-of-VDPVs_Aug2016_EN.pdf.

§§ Dashes indicate that no confirmed cases were found.

¶¶ For this country, *MMWR* uses the U.S. State Department short-form name "Burma"; WHO uses "Myanmar."

FIGURE. Combined performance indicators for the quality of acute flaccid paralysis (AFP) surveillance* in subnational areas of 40 priority countries† — World Health Organization (WHO) African, Eastern Mediterranean, South-East Asia, and Western Pacific regions, 2019



Abbreviation: NPAFP = nonpolio acute flaccid paralysis.

* Targets: ≥2 NPAFP cases per 100,000 children aged <15 years per year and ≥80% of persons with AFP having two stool specimens collected ≥24 hours apart within 14 days of paralysis onset and arrival of these specimens at a WHO-accredited laboratory by reverse cold chain and in good condition.

† For Burma (Myanmar), MMWR uses the U.S. State Department short-form name "Burma"; WHO uses "Myanmar."

16% of the population lived in areas meeting both indicators in 2019 (Figure).

In the Western Pacific Region (WPR), surveillance performance was assessed for three countries (Malaysia, Papua New Guinea, and Philippines) (Table 1). No priority country met both AFP surveillance indicators in 2018 and 2019. Two cVDPV type 1 (cVDPV1) cases reported in Philippines in 2019 were genetically linked to three cVDPV1 cases reported in Malaysia; 13 cVDPV2 cases were also reported in Philippines in 2019. Environmental surveillance also detected genetically linked cVDPV1 and cVDPV2 isolates in both countries. One cVDPV2 case was reported in China in 2019. Subnational NPAFP rate and stool adequacy indicators were suboptimal in Philippines and Malaysia in 2018 and 2019, indicating gaps in AFP case detection or investigation. Although Papua New Guinea met the NPAFP target performance indicator in both years, the stool adequacy target was not met at the national level.

In the South-East Asia Region (SEAR), surveillance performance was assessed for two countries (Indonesia and Burma

[Myanmar][¶]) (Table 1). In 2018, both countries met both surveillance indicators and in 2019, one Burma (Myanmar) met both indicators. Six cVDPV1 cases were reported in Burma (Myanmar) in 2019, which had subnational weaknesses in NPAFP surveillance (Figure). No cVDPV1 cases were reported in Indonesia in 2019 after detection of one cVDPV1 case in 2018; however, weaknesses in subnational surveillance performance were identified in 2019.

Environmental Surveillance

Environmental surveillance enhances the sensitivity of poliovirus surveillance by identifying poliovirus circulation that might occur in the absence of detected AFP cases (*6*), as occurred in 2018 and 2019 in Cameroon, Côte d'Ivoire,[**] and Kenya; environmental surveillance confirmed cVDPV circulation well before AFP case detection in China, Central African Republic, Ghana, Malaysia, Nigeria, Philippines, and Somalia. In Iran, WPV1 was isolated from sewage in 2019 in the absence of detected AFP cases.

In Nigeria, environmental surveillance resulted in 45 cVDPV2 isolates in 2018 and 60 in 2019. In 2018, six WPV1 genetic clusters (isolates with ≥95% genetic relatedness) were detected in environmental surveillance from seven provinces in Afghanistan. In Pakistan, eight genetic clusters were detected from 28 districts in four provinces and in the Islamabad Capital Territory. In Pakistan, the number of WPV1 environmental surveillance detections increased in 2019, compared with that in 2018, with the largest increase in the Sindh province.

Global Polio Laboratory Network (GPLN)

GPLN comprises 145 poliovirus laboratories in the six WHO regions. GPLN laboratories implement standardized protocols to 1) isolate polioviruses (all laboratories); 2) conduct intratypic differentiation (ITD) to identify WPV, Sabin (oral polio vaccine) poliovirus and VDPV (134 laboratories); and 3) conduct genomic sequencing (28 laboratories). Poliovirus transmission pathways are monitored through sequence analysis of an isolate's viral capsid protein (VP1) coding region. Standard AFP timeliness indicators specify that laboratories should report ≥80% of poliovirus virus isolation results within 14 days of specimen receipt, ≥80% of ITD results within 7 days of isolate receipt, and ≥80% of sequencing results within 7 days of ITD result. The combined field and laboratory performance indicator is reporting of ITD results for ≥80% of isolates within 60 days of paralysis onset in AFP cases. The accuracy and quality of testing at GPLN laboratories are monitored through an annual accreditation program of onsite reviews and proficiency testing (*7*). Another accreditation checklist is used for laboratories conducting environmental surveillance, with separate timeliness indicators.

GPLN tested 190,055 stool specimens in 2018 and 219,049 stool specimens in 2019 (Table 2). WPV1 was isolated from 33 stool specimens in 2018 and from 156 stool specimens in 2019. cVDPVs were isolated from 105 AFP patients in 2018 and from 437 in 2019. From 2018 to 2019, the number of stool specimens with cVDPV isolates increased from 65 to 303 (366%) in AFR, from 13 to 50 in EMR (284%), from one to 10 (90%) in SEAR, and from 26 to 74 (185%) in WPR. In 2018 and 2019, all regions met the timeliness indicator for poliovirus isolation.

In 2019, the South Asia genotype (the only WPV1 genotype circulating globally since 2016) was detected in Afghanistan and Pakistan. There were no "orphan" WPV1 isolates (those with ≤98.5% genetic identity in VP1, compared with other isolates) from AFP patients in 2018, and there were five in 2019 (two in Afghanistan and three in Pakistan), indicating possible gaps in AFP surveillance. The genetic diversity of WPV1 isolates in Afghanistan and Pakistan increased during the reporting period because of the high level of WPV1 circulation during the low season from October to May (*8*). Genomic sequence analysis identified seven cVDPV2 emergences in six countries in 2018 and 39 cVDPV2 emergences in 19 countries in 2019 (*4*,*5*).

Summary

What is already known about this topic?

High-quality surveillance is essential to achieving polio eradication. Acute flaccid paralysis (AFP) surveillance is the primary means of detecting poliovirus, supplemented by environmental surveillance in selected locations.

What is added by this report?

In 2019, 25 (63%) of 40 priority countries met AFP surveillance indicators nationally. The proportion of priority countries that achieved targeted AFP detection and stool collection adequacy indicators declined from 2018 to 2019. Surveillance gaps remained at the subnational level.

What are the implications for public health practice?

All countries must resolve national and subnational surveillance gaps to ensure that poliovirus circulation is quickly detected. Important activities to enhance and maintain sensitive surveillance include effective case detection, investigation, reporting, monitoring, and supervision.

[¶] For this country, *MMWR* uses the U.S. State Department short-form name "Burma"; WHO uses "Myanmar."

[**] Côte d'Ivoire has confirmed three cVDPV2 cases in 2020 as of May 22.

TABLE 2. Number of poliovirus isolates from stool specimens of persons with acute flaccid paralysis (AFP) and timing of results — World Health Organization (WHO) regions, 2018 and 2019*

WHO region/Year	No. of specimens	No. of poliovirus isolates			% of poliovirus isolation on time**	% of ITD results within 7 days of receipt of specimen††	% of ITD results within 60 days of paralysis onset
		Wild†	Sabin§	cVDPV¶			
African							
2018	51,292	0	2,547	65	94	98	96
2019	51,634	0	1,207	303	93	99	94
Americas							
2018	1,886	0	47	0	86	100	100
2019	1,957	0	15	0	80	78	88
Eastern Mediterranean							
2018	40,419	33	1,749	13	92	99	97
2019	58,924	156	1,927	50	92	99	92
European							
2018	3,274	0	71	0	84	92	62
2019	3,295	0	52	0	83	100	87
South-East Asia							
2018	79,566	0	1,970	1	97	100	99
2019	88,734	0	1,807	10	94	98	97
Western Pacific							
2018	13,638	0	348	26	97	99	68
2019	14,505	0	164	74	97	96	71
Total§§							
2018	**190,055**	**33**	**6,732**	**105**	**95**	**99**	**95**
2019	**219,049**	**312**	**5,172**	**437**	**95**	**99**	**96**

Abbreviations: cVDPV = circulating vaccine-derived poliovirus; ITD = intratypic differentiation.
* 2018 data as of March 4, 2019 ; 2019 data as of March 18, 2020.
† Number of AFP cases with WPV isolates.
§ Either 1) concordant Sabin-like results in ITD test and VDPV screening, or 2) ≤1% VP1 nucleotide sequence difference compared with Sabin vaccine virus (≤0.6% for type 2).
¶ For poliovirus types 1 and 3, 10 or more VP1 nucleotide differences from the respective poliovirus; for poliovirus type 2, six or more VP1 nucleotide differences from Sabin type 2 poliovirus.
** Results reported within 14 days of receipt of specimen.
†† Results of ITD reported within 7 days of receipt of specimen.
§§ For the last three indicators, total represents weighted mean percentage of indicators from the six regions.

Discussion

Although many of the 40 priority countries evaluated met national-level AFP surveillance performance indicators, the percentage of 2019 priority countries meeting both indicators declined overall from 83% in 2018 to 63% in 2019. Critical subnational gaps were also reported in almost all countries assessed, and the decline in the number of countries meeting the stool adequacy target from 2018 to 2019 indicates challenges in timely detection and investigation of suspected AFP cases or in specimen transport and handling. GPEI has outlined activities to enhance polio surveillance in high-priority countries (*9*), and the surveillance status report (*10*) details efforts to address current challenges; despite efforts, however, shortcomings remain in detection, investigation, reporting, and monitoring. Competing priorities, limited logistical support, and heavy workloads could all contribute to suboptimal surveillance performance. The coronavirus disease 2019 (COVID-19) pandemic might exacerbate these existing challenges and present new ones in polio immunization, surveillance, and laboratory testing activities†† as a result of diminished access to health care and immunization and concerns about exposure to COVID-19 cases.

The findings in this report are subject to at least three limitations. First, matters related to security, hard-to-reach subpopulations, and other factors could affect subnational AFP surveillance indicators and limit their interpretation. Second, high NPAFP rates do not necessarily indicate highly sensitive

†† GPEI has offered its global technical and material assets to support the coronavirus disease 2019 (COVID-19) pandemic response and has recommended that preventive and response polio supplementary immunization activities be suspended until June 1, 2020, or later. AFP and environmental surveillance activities should continue as possible and according to countries' COVID-19 contexts, as should preparations for the use of the novel type 2 oral poliovirus vaccine, scheduled for introduction in select countries in mid-2020.

surveillance because not all reported AFP cases meet the case definition, and some AFP cases might not be detected. Finally, the accuracy of stool specimen collection timeliness depends on whether the field investigator can elicit the actual date of paralysis onset.

High-quality AFP surveillance is critical to detecting poliovirus transmission. Important activities to enhance and maintain sensitive surveillance include effective case detection, investigation, reporting, monitoring, and supervision. Where the effects of COVID-19 are particularly devastating, efforts at the national and subnational levels should be made to restore curative health systems, preventive services, and overall infectious disease surveillance and control activities and, in the process, ensure availability of resources to enhance poliovirus surveillance and safeguard progress toward polio eradication. Continuous assessment of surveillance performance at the national and subnational levels must be undertaken to identify and promptly address gaps to achieve eradication of poliovirus worldwide.

Acknowledgments

World Health Organization (WHO) Global Polio Laboratory Network (GPLN) regional sequencing laboratories and GPLN Regional Coordinators at the WHO Regional Office for the Eastern Mediterranean, WHO Regional Office for the Americas, WHO Regional Office for Europe, WHO Regional Office for the Western Pacific, WHO Regional Office for South-East Asia, and WHO Regional Office for Africa; Staff members of the Polio Eradication Branch, Global Immunization Division, Center for Global Health, CDC; Polio and Picornavirus Laboratory Branch, Division of Viral Diseases, National Center for Immunization and Respiratory Diseases, CDC; Geospatial Research, Analysis, and Services Program, Agency for Toxic Substances and Disease Registry; and Division of Emergency Operations, Center for Preparedness and Response, CDC.

Corresponding author: Jacquelyn S. Lickness, wxx3@cdc.gov, 404-639-8039.

[1]Global Immunization Division, Center for Global Health, CDC; [2]Polio Eradication Department, World Health Organization, Geneva, Switzerland; [3]Division of Viral Diseases, National Center for Immunization and Respiratory Diseases, CDC; [4]Polio Eradication Department, World Health Organization, Brazzaville, Republic of Congo; [5]Polio Eradication Department, World Health Organization, Amman, Jordan; [6]Polio Eradication Department, World Health Organization, Copenhagen, Denmark; [7]Polio Eradication Department, World Health Organization, Manila, Philippines; [8]Polio Eradication Department, World Health Organization, New Delhi, India; [9]Polio Eradication Department, World Health Organization, Washington, DC.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. Greene SA, Ahmed J, Datta SD, et al. Progress toward polio eradication—worldwide, January 2017–March 2019. MMWR Morb Mortal Wkly Rep 2019;68:458–62. https://doi.org/10.15585/mmwr.mm6820a3
2. Patel JC, Diop OM, Gardner T, et al. Surveillance to track progress toward polio eradication—worldwide, 2017–2018. MMWR Morb Mortal Wkly Rep 2019;68:312–8. https://doi.org/10.15585/mmwr.mm6813a4
3. World Health Organization. WHO-recommended surveillance standard of poliomyelitis. Geneva, Switzerland: World Health Organization; 2018. https://www.who.int/immunization/monitoring_surveillance/burden/vpd/WHO_SurveillanceVaccinePreventable_18_Polio_R2.pdf?ua=1
4. Alleman MM, Jorba J, Greene SA, et al. Update on vaccine-derived poliovirus outbreaks—worldwide, July 2019–February 2020. MMWR Morb Mortal Wkly Rep 2020;69:489–95. https://doi.org/10.15585/mmwr.mm6916a1
5. Adamu US, Archer WR, Braka F, et al. Progress toward poliomyelitis eradication—Nigeria, January 2018–May 2019. MMWR Morb Mortal Wkly Rep 2019;68:642–6. https://doi.org/10.15585/mmwr.mm6829a3
6. Asghar H, Diop OM, Weldegebriel G, et al. Environmental surveillance for polioviruses in the Global Polio Eradication Initiative. J Infect Dis 2014;210(Suppl 1):S294–303. https://doi.org/10.1093/infdis/jiu384
7. Diop OM, Kew OM, de Gourville EM, Pallansch MA. The Global Polio Laboratory Network as a platform for the viral vaccine-preventable and emerging diseases laboratory networks. J Infect Dis 2017;216(Suppl_1):S299–307. https://doi.org/10.1093/infdis/jix092
8. Hsu CH, Kader M, Mahamud A, et al. Progress toward poliomyelitis eradication—Pakistan, January 2018–September 2019. MMWR Morb Mortal Wkly Rep 2019;68:1029–33. https://doi.org/10.15585/mmwr.mm6845a5
9. Global Polio Eradication Initiative. Global polio surveillance action plan, 2018–2020. Geneva, Switzerland: Global Polio Eradication Initiative; 2019. http://polioeradication.org/wp-content/uploads/2016/07/GPEI-global-polio-surveillance-action-plan-2018-2020-EN.pdf
10. World Health Organization. Global polio surveillance status report, 2019. Geneva, Switzerland: World Health Organization; 2019. http://polioeradication.org/wp-content/uploads/2020/02/Polio-surveillance-status-report-2019.pdf

Decline in Child Vaccination Coverage During the COVID-19 Pandemic — Michigan Care Improvement Registry, May 2016–May 2020

Cristi A. Bramer, MPH[1]; Lynsey M. Kimmins, MPH[1]; Robert Swanson, MPH[1]; Jeremy Kuo, MPH[1]; Patricia Vranesich[1,2]; Lisa A. Jacques-Carroll, MSW[2]; Angela K. Shen, ScD[2,3]

On May 18, 2020, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

On March 13, 2020, the United States declared a national state of emergency to control the pandemic spread of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19) (*1*). Public health response measures to mitigate the pandemic have centered on social distancing and quarantine policies, including shelter-in-place and stay-at-home orders. Michigan implemented a stay-at-home order on March 23, 2020, to facilitate social distancing (*2*). Such strategies might result in decreased accessibility to routine immunization services, leaving children at risk for vaccine-preventable diseases and their complications (*3*). To evaluate whether vaccination coverage has changed during the pandemic, data from the Michigan Care Improvement Registry (the state's immunization information system) (MCIR) were analyzed. Changes in vaccine doses administered to children and the effects of those changes on up-to-date status were examined for vaccinations recommended at milestone ages corresponding to the end of an Advisory Committee on Immunization Practices (ACIP) recommendation period for one or more vaccines (*4*).

The vaccination status of milestone age cohorts of children at ages 1, 3, 5, 7, 16, 19, and 24 months was assessed, with each cohort including an average sample size of 9,269 for the study period years 2016–2019, and 9,539 for 2020. Up-to-date status for individual vaccines and the recommended age-based vaccine series* were assessed at a point in time in May 2020 and compared with 1-month age cohort assessments for points in time in May 2016–May 2019. The number of noninfluenza vaccine doses administered and reported to MCIR for children aged ≤18 years and aged ≤24 months also were examined during January–April 2020, compared with averages for the same period in 2018 and 2019.

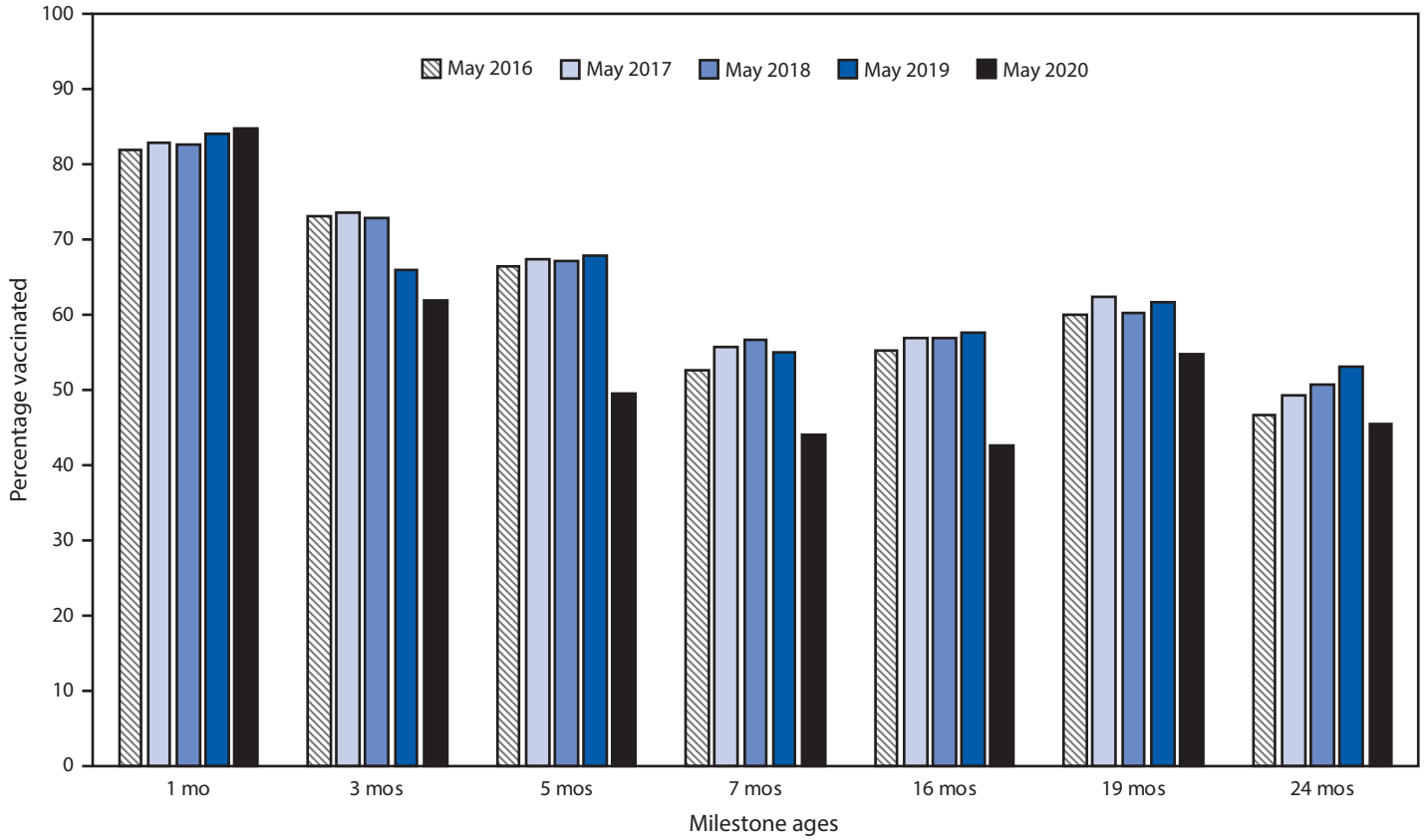
Vaccination coverage declined in all milestone age cohorts, except for birth-dose hepatitis B coverage, which is typically administered in the hospital setting (Figure). Among children aged 5 months, up-to-date status for all recommended vaccines declined from approximately two thirds of children during 2016–2019 (66.6%, 67.4%, 67.3%, 67.9%, respectively) to fewer than half (49.7%) in May 2020. For the 16-month age cohort, coverage with all recommended vaccines declined, with measles-containing vaccination coverage decreasing from 76.1% in May 2019 to 70.9% in May 2020. In addition to a decline in up-to-date status in almost all age cohorts, the number of noninfluenza vaccine doses administered and reported for children aged ≤18 years decreased 21.5%, and the number of doses administered to children aged ≤24 months decreased 15.5% during January–April 2020, compared with the same averaged periods in 2018 and 2019.

Up-to-date series coverage for each age cohort (1, 3, 5, 7, 16, 19, and 24 months) assessed in May 2020 was lower for Medicaid-enrolled children than for those children not enrolled in Medicaid. The largest difference was in the age 7 months cohort assessed in May 2020; in that cohort, 34.6% of Medicaid-enrolled children were up-to-date for their recommended series, compared with 55.0% of children not enrolled in Medicaid.

As the nation continues efforts to mitigate transmission of SARS-CoV-2, disruption of essential health services might occur, including in outpatient settings. Many provider offices have transitioned to telemedicine practices, where possible, to provide continuity of care in the medical home (*5*). Although some components of a well-child visit can be completed through telemedicine video conferences, immunization services require an in-person visit. Strategies to maintain immunization services include dedicating specific clinics, rooms, or buildings for sick visits and well visits; reducing the number of patients on-site at any one time; closing waiting rooms or registration areas, and having patients check in by phone and receive vaccinations from their vehicles in the parking lot (*6*). Providers can use their patients' electronic health records and immunization information systems to work with families to schedule in-person appointments, identify children who have missed recommended vaccinations, and assure parents that strict infection control practices are in place. The observed declines in vaccination coverage might leave young children and communities vulnerable to vaccine-preventable

* Milestone age-based cohort assessments of recommended vaccine doses received were as follows: 1 month — 1st dose hepatitis B (HepB) within 3 days of life; 3 months — 2nd dose HepB, 1 rotavirus (Rota), 1 diphtheria, tetanus, and acellular pertussis (DTaP), 1 *Haemophilus influenzae* type b (Hib), 1 pneumococcal conjugate (PCV), 1 inactivated poliovirus (IPV); 5 months — 2 HepB, 2 Rota, 2 DTaP, 2 Hib, 2 PCV, 2 IPV; 7 months — 2 HepB, up-to-date (UTD) Rota, 3 DTaP, UTD Hib, 3 PCV, 2 IPV; 16 months — 2 HepB, 3 DTaP, UTD Hib, 4 PCV, 2 IPV, 1 measles, mumps, rubella (MMR), 1 varicella (Var); 19 months — 3 HepB, 4 DTaP, UTD Hib, 4 PCV, 3 IPV, 1 MMR, 1 Var; 24 months — 3 HepB, 4 DTaP, UTD Hib, 4 PCV, 3 IPV, 1 MMR, 1 Var, 2 hepatitis A.

FIGURE. Percentage of Michigan infants and children vaccinated at milestone ages* — Michigan Care Improvement Registry, May 2016, 2017, 2018, 2019, and 2020



* Milestone age cohorts (average sample size: 9,269 for 2016–2019, and 9,539 for 2020) were assessed at a point in time in May of each year. Milestone age-based cohort assessments of recommended vaccine doses received were as follows: 1 month — 1st dose hepatitis B (HepB) within 3 days of life; 3 months — 2nd dose HepB, 1 rotavirus (Rota), 1 diphtheria, tetanus, and acellular pertussis (DTaP), 1 *Haemophilus influenzae* type b (Hib), 1 pneumococcal conjugate (PCV), 1 inactivated poliovirus (IPV); 5 months — 2 HepB, 2 Rota, 2 DTaP, 2 Hib, 2 PCV, 2 IPV; 7 months — 2 HepB, up-to-date (UTD) Rota, 3 DTaP, UTD Hib, 3 PCV, 2 IPV; 16 months — 2 HepB, 3 DTaP, UTD Hib, 4 PCV, 2 IPV, 1 measles, mumps, rubella (MMR), 1 varicella (Var); 19 months — 3 HepB, 4 DTaP, UTD Hib, 4 PCV, 3 IPV, 1 MMR, 1 Var; 24 months — 3 HepB, 4 DTaP, UTD Hib, 4 PCV, 3 IPV, 1 MMR, 1 Var, 2 hepatitis A.

diseases such as measles. If measles vaccination coverage of 90%–95% (the level needed to establish herd immunity) is not achieved, measles outbreaks can occur. Concerted efforts are needed to ensure rapid catch-up for children who are not up-to-date with measles-containing vaccines as well as other ACIP-recommended vaccinations (*4*). Michigan continues to work with local health departments and vaccine providers to regularly assess patient populations for vaccination coverage, promote tools to conduct reminders and recalls, and develop provider and parent education regarding the continued need for vaccination during pandemics.

Corresponding author: Angela K. Shen, shenak@email.chop.edu, 301-467-7770.

[1]Division of Immunization, Michigan Department of Health and Human Services; [2]Immunization Action Coalition, Saint Paul, Minnesota; [3]Vaccine Education Center, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. CDC. Coronavirus disease 2019 (COVID-19). Cases in the U.S. Atlanta, GA: US Department of Health and Human Services, CDC; 2020. https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html
2. State of Michigan. Coronavirus. Stay home. Stay safe. Save lives. Lansing, MI: State of Michigan; 2020. https://www.michigan.gov/coronavirus/0,9753,7-406-98159-52264--,00.html
3. Santoli JM, Lindley MC, DeSilva MB, et al. Effects of the COVID-19 pandemic on routine pediatric vaccine ordering and administration—United States, 2020. MMWR Morb Mortal Wkly Rep 2020;69:591–3. https://doi.org/10.15585/mmwr.mm6919e2
4. CDC. Recommended child and adolescent immunization schedule for ages 18 years or younger, United States, 2020. Atlanta, GA: US Department of Health and Human Services, CDC; 2020. https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html
5. American Academy of Family Physicians. Inside look at using telemedicine during COVID-19 pandemic, 2020. Leawood, KS: American Academy of Family Physicians; 2020. https://www.aafp.org/news/health-of-the-public/20200323covidtelehealth.html
6. Washington State Department of Health. Please continue vaccinating patients during COVID-19. Seattle, WA: Washington State Department of Health; 2020. https://files.constantcontact.com/9817310a001/66cddbb8-c4f9-44b4-a762-20e04beaaed3.pdf

High COVID-19 Attack Rate Among Attendees at Events at a Church — Arkansas, March 2020

Allison James, DVM, PhD[1,2]; Lesli Eagle[1]; Cassandra Phillips[1]; D. Stephen Hedges, MPH[1]; Cathie Bodenhamer[1]; Robin Brown, MPAS, MPH[1]; J. Gary Wheeler, MD[1]; Hannah Kirking, MD[3]

On May 19, 2020, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

On March 16, 2020, the day that national social distancing guidelines were released (*1*), the Arkansas Department of Health (ADH) was notified of two cases of coronavirus disease 2019 (COVID-19) from a rural county of approximately 25,000 persons; these cases were the first identified in this county. The two cases occurred in a husband and wife; the husband is the pastor at a local church (church A). The couple (the index cases) attended church-related events during March 6–8, and developed nonspecific respiratory symptoms and fever on March 10 (wife) and 11 (husband). Before his symptoms had developed, the husband attended a Bible study group on March 11. Including the index cases, 35 confirmed COVID-19 cases occurred among 92 (38%) persons who attended events held at church A during March 6–11; three patients died. The age-specific attack rates among persons aged ≤18 years, 19–64 years, and ≥65 years were 6.3%, 59.4%, and 50.0%, respectively. During contact tracing, at least 26 additional persons with confirmed COVID-19 cases were identified among community members who reported contact with church A attendees and likely were infected by them; one of the additional persons was hospitalized and subsequently died. This outbreak highlights the potential for widespread transmission of SARS-CoV-2, the virus that causes COVID-19, both at group gatherings during church events and within the broader community. These findings underscore the opportunity for faith-based organizations to prevent COVID-19 by following local authorities' guidance and the U.S. Government's Guidelines: Opening Up America Again (*2*) regarding modification of activities to prevent virus transmission during the COVID-19 pandemic.

On March 10 and 11, the wife of the church pastor, aged 56 years, and the pastor, aged 57 years, developed fever and cough. On March 12, the pastor, after becoming aware of similar nonspecific respiratory symptoms among members of their congregation, closed church A indefinitely. Because of fever, cough, and increasing shortness of breath, the couple sought testing for SARS-CoV-2 on March 13; both were notified of positive results by reverse transcription–polymerase chain reaction testing on March 16. The same day, ADH staff members began an investigation to identify how the couple had been exposed and to trace persons with whom they had been in contact. Based on their activities and onset dates, they likely were infected at church A events during March 6–8, and the husband might have then exposed others while presymptomatic during a Bible study event held on March 11.

During March and April 2020, all persons in Arkansas who received testing for SARS-CoV-2 at any laboratory were entered into a database (Research Electronic Data Capture [REDCap]; version 8.8.0; Vanderbilt University) managed by ADH. Using a standardized questionnaire, ADH staff members interviewed persons who had positive test results to ascertain symptoms, onset date, and potential exposure information, including epidemiologic linkages to other COVID-19 patients; this information was stored in the database. Close contacts of patients with laboratory-confirmed cases of COVID-19 were interviewed and enrolled in active symptom monitoring; those who developed symptoms were tested and their information was also entered into the database. Church A–associated cases were defined as those in 1) persons who had laboratory results positive for SARS-CoV-2 who identified contact with church A attendees as a source of exposure and 2) actively monitored contacts of church attendees who had a test result positive for SARS-CoV-2 after becoming symptomatic.

The public health investigation focused on the transmission of SARS-CoV-2 among persons who attended church A events during March 6–11. To facilitate the investigation, the pastor and his wife generated a list of 94 church members and guests who had registered for, or who, based on the couple's recollection, might have attended these events.

During March 6–8, church A hosted a 3-day children's event which consisted of two separate 1.5-hour indoor sessions (one on March 6 and one on March 7) and two, 1-hour indoor sessions during normal church services on March 8. This event was led by two guests from another state. During each session, children participated in competitions to collect offerings by hand from adults, resulting in brief close contact among nearly all children and attending adults. On March 7, food prepared by church members was served buffet-style. A separate Bible study event was held March 11; the pastor reported most attendees sat apart from one another in a large room at this event. Most children and some adults participated in singing during the children's event; no singing occurred during the March 11 Bible study. Among all 94 persons who might have attended any of the events, 19 (20%) attended both the children's event and Bible study.

Summary

What is already known about this topic?

Large gatherings pose a risk for SARS-CoV-2 transmission.

What is added by this report?

Among 92 attendees at a rural Arkansas church during March 6–11, 35 (38%) developed laboratory-confirmed COVID-19, and three persons died. Highest attack rates were in persons aged 19–64 years (59%) and ≥65 years (50%). An additional 26 cases linked to the church occurred in the community, including one death.

What are the implications for public health practice?

Faith-based organizations should work with local health officials to determine how to implement the U.S. Government guidelines for modifying activities during the COVID-19 pandemic to prevent transmission of the virus to their members and their communities.

The husband and wife were the first to be recognized by ADH among the 35 patients with laboratory-confirmed COVID-19 associated with church A attendance identified through April 22; their illnesses represent the index cases. During the investigation, two persons who were symptomatic (not the husband and wife) during March 6–8 were identified; these are considered the primary cases because they likely initiated the chain of transmission among church attendees. Additional cases included those in persons who attended any church A events during March 6–11, but whose symptom onset occurred on or after March 8, which was 2 days after the earliest possible church A exposure. One asymptomatic attendee who sought testing after household members became ill was included among these additional cases.

Consistent with CDC recommendations for laboratory testing at that time (*3*), clinical criteria for testing included cough, fever, or shortness of breath; asymptomatic persons were not routinely tested. To account for this limitation when calculating attack rates, upper and lower boundaries for the attack rates were estimated by dividing the total number of persons with laboratory-confirmed COVID-19 by the number of persons tested for SARS-CoV-2 and by the number of persons who attended church A during March 6–11, respectively. All analyses were performed using R statistical software (version 4.0.0; The R Foundation). Risk ratios were calculated to compare attack rates by age, sex, and attendance dates. Fisher's exact test was used to calculate two-sided p-values; p-values <0.05 were considered statistically significant.

Overall, 94 persons attended church A events during March 6–11 and might have been exposed to the index patients or to another infectious patient at the same event; among these persons, 92 were successfully contacted and are included in the analysis. Similar proportions of church A attendees were aged ≤18 years (35%), 19–64 years (35%), and ≥65 years (30%) (Table 1). However, a higher proportion of adults aged 19–64 years and ≥65 years were tested (72% and 50%, respectively), and received positive test results (59% and 50%), than did younger persons. Forty-five persons were tested for SARS-CoV-2, among whom 35 (77.8%) received positive test results (Table 2).

During the investigation, two church A participants who attended the March 6–8 children's event were found to have had onset of symptoms on March 6 and 7; these represent the primary cases and likely were the source of infection of other church A attendees (Figure). The two out-of-state guests developed respiratory symptoms during March 9–10 and later received diagnoses of laboratory-confirmed COVID-19, suggesting that exposure to the primary cases resulted in their infections. The two primary cases were not linked except through the church; the persons lived locally and reported no travel and had no known contact with a traveler or anyone with confirmed COVID-19. Patient interviews revealed no additional common exposures among church attendees.

The estimated attack rate ranged from 38% (35 cases among all 92 church A event attendees) to 78% (35 cases among 45 church A event attendees who were tested for SARS-CoV-2). When stratified by age, attack rates were significantly lower among persons aged ≤18 years (6.3%–25.0%) than among adults aged 19–64 years (59.4%–82.6%) (p<0.01). The risk ratios for persons aged ≤18 years compared with those for persons aged 19–64 years were 0.1–0.3. No severe illnesses occurred in children. Among the 35 persons with laboratory-confirmed COVID-19, seven (20%) were hospitalized; three (9%) patients died.

At least 26 additional confirmed COVID-19 cases were identified among community members who, during contact tracing, reported contact with one or more of the 35 church A members with COVID-19 as an exposure. These persons likely were infected by church A attendees. Among these 26 persons, one was hospitalized and subsequently died. Thus, as of April 22, 61 confirmed cases (including eight [13%] hospitalizations and four [7%] deaths) had been identified in persons directly and indirectly associated with church A events.

Discussion

This investigation identified 35 confirmed COVID-19 cases among 92 attendees at church A events during March 6–11; estimated attack rates ranged from 38% to 78%. Despite canceling in-person church activities and closing the church as soon as it was recognized that several members of the congregation had become ill, widespread transmission within church A and within the surrounding community occurred. The primary patients had no known COVID-19 exposures in

TABLE 1. Demographic characteristics, church A event attendance, and SARS-CoV-2 testing status of persons who attended church A events where persons with confirmed COVID-19 (N = 92) also attended — Arkansas, March 2020

Characteristic	All attendees No. (%)*	No. (%) tested†	p-value§	No. (%) who tested positive†	p-value§
Total	**92 (100)**	**45 (49)**	—	**35 (38)**	—
Age group (yrs)					
≤18	32 (35)	8 (25)	0.001	2 (6)	0.004
18–64	32 (35)	23 (72)		19 (59)	
≥65	28 (30)	14 (50)		14 (50)	
Sex					
Male	44 (48)	22 (50)	1.0	17 (39)	1.0
Female	48 (52)	23 (48)		18 (38)	
Church A event attendance					
Weekend only (Mar 6–8)	64 (70)	33 (52)	0.28	28 (44)	0.16
Bible study only (Mar 11)	9 (10)	2 (22)		1 (11)	
Both weekend and Bible study	19 (21)	10 (53)		6 (32)	

Abbreviation: COVID-19 = coronavirus disease 2019.
* Includes all persons who were confirmed to have attended church A events during March 6–11; percentages are column percentages.
† Percentage of attendees (row percentages).
§ Calculated with Fisher's exact test.

TABLE 2. Estimated attack rates of COVID-19 among attendees at church A events — Arkansas, March 6–11, 2020

	All Mar 6–11 church A attendees (lower bound)			All tested Mar 6–11 church A attendees (upper bound)		
Characteristic	**No. of cases/no. exposed (%)**	**Risk ratio (95% CI)**	**p-value**	**No. of cases/no. tested (%)**	**Risk ratio (95% CI)**	**p-value**
Overall	**35/92 (38.0)**	—	—	**35/45 (77.8)**	—	—
Age group (yrs)						
≤18	2/32 (6.3)	0.1 (0.03–0.4)	<0.001	2/8 (25.0)	0.3 (0.1–1.0)	0.003
19–64	19/32 (59.4)	Referent	—	19/23 (82.6)	Referent	—
≥65	14/28 (50.0)	0.8 (0.5–1.3)	0.47	14/14 (100.0)	1.2 (1.0–1.5)	0.10
Sex						
Male	17/44 (38.6)	1.0 (0.6–1.7)	0.91	17/22 (77.3)	1.0 (0.7–1.3)	0.94
Female	18/48 (37.5)	Referent	—	18/23 (78.3)	Referent	—
Church A event attendance						
Weekend only (Mar 6–8)	28/64 (43.8)	1.4 (0.7–2.8)	0.3	28/33 (84.8)	1.4 (0.8–2.4)	0.09
Bible study only (Mar 11)	1/9 (11.1)	0.4 (0.05–2.5)	0.25	1/2 (50.0)	1.7 (0.4–6.8)	0.21
Both weekend and Bible study	6/19 (31.6)	Referent	—	6/10 (60.0)	Referent	—

Abbreviations: CI = confidence interval; COVID-19 = coronavirus disease 2019.

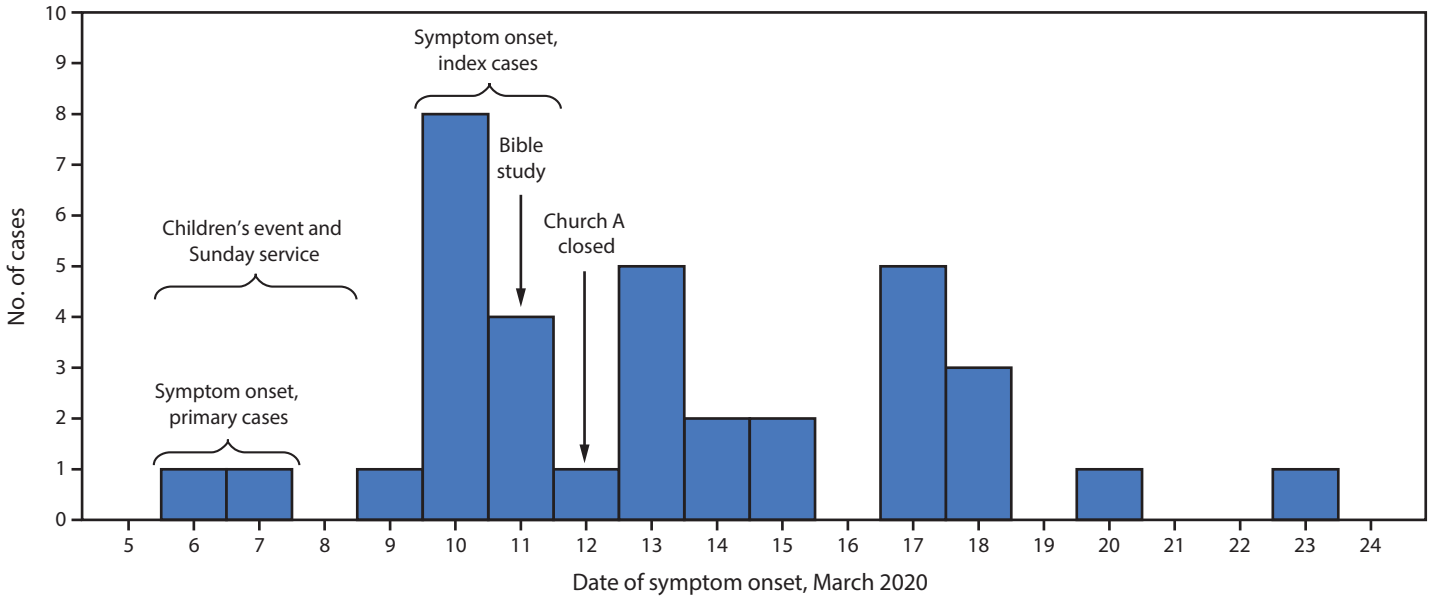
the 14 days preceding their symptom onset dates, suggesting that local transmission was occurring before case detection.

Children represented 35% of all church A attendees but accounted for only 18% of persons who received testing and 6% of confirmed cases. These findings are consistent with those from other reports suggesting that many children with COVID-19 experience more asymptomatic infections or milder symptoms and have lower hospitalization rates than do adults (*4*,*5*). The role of asymptomatic or mildly symptomatic children in SARS-CoV-2 transmission remains unknown and represents a critical knowledge gap as officials consider reopening public places.

The risk for symptomatic infection among adults aged ≥65 years was not higher than that among adults aged 19–64 years. However, six of the seven hospitalized persons and all three deaths occurred in persons aged ≥65 years, consistent with other U.S. data indicating a higher risk for COVID-19–associated hospitalization and death among persons aged ≥65 years (*6*).

The findings in this report are subject to at least four limitations. First, some infected persons might have been missed because they did not seek testing, were ineligible for testing based on criteria at the time, or were unable to access testing. Second, although no previous cases had been reported from this county, undetected low-level community transmission was likely, and some patients in this cluster might have had exposures outside the church. Third, risk of exposure likely varied among attendees but could not be characterized because data regarding individual behaviors (e.g., shaking hands or hugging) were not collected. Finally, the number of cases beyond the cohort of church attendees likely is undercounted because tracking out-of-state transmission was not possible, and patients might not have identified church members as their source of exposure.

FIGURE. Date of symptom onset* among persons with laboratory-confirmed cases of COVID-19 (N = 35) who attended March 6–11 church A events — Arkansas, March 6–23, 2020



Abbreviation: COVID-19 = coronavirus disease 2019.
* One asymptomatic person who had a positive test result is included on the date of specimen collection (March 18).

High transmission rates of SARS-CoV-2 have been reported from hospitals (*7*), long-term care facilities (*8*), family gatherings (*9*), a choir practice (*10*), and, in this report, church events. Faith-based organizations that are operating or planning to resume in-person operations, including regular services, funerals, or other events, should be aware of the potential for high rates of transmission of SARS-CoV-2. These organizations should work with local health officials to determine how to implement the U.S. Government's guidelines for modifying activities during the COVID-19 pandemic to prevent transmission of the virus to their members and their communities (*2*).

Acknowledgments

Members of the congregation of church A, including the pastor and his wife; Arkansas Department of Health; Suzanne Beavers, CDC; Laura Rothfeldt, Arkansas Department of Health; state and local health departments where out-of-state visitors resided.

Corresponding author: Allison E. James, hwj7@cdc.gov, 501-614-5278.

[1]Arkansas Department of Health; [2]Epidemic Intelligence Service, CDC; [3]COVID-19 Response Team, CDC.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. Office of the President of the United States. Coronavirus guidelines for America. Washington, DC: Office of the President of the United States; 2020. https://www.whitehouse.gov/briefings-statements/coronavirus-guidelines-america/
2. Office of the President of the United States. Guidelines: opening up America again. Washington, DC: Office of the President of the United States; 2020. https://www.whitehouse.gov/openingamerica/
3. CDC. Health Alert Network: update and interim guidance on outbreak of coronavirus disease 2019 (COVID-19). Atlanta, GA: US Department of Health and Human Services, CDC; 2020. https://emergency.cdc.gov/han/2020/HAN00428.asp
4. Bialek S, Gierke R, Hughes M, McNamara LA, Pilishvili T, Skoff T; CDC COVID-19 Response Team. Coronavirus disease 2019 in children—United States, February 12–April 2, 2020. MMWR Morb Mortal Wkly Rep 2020;69:422–6. https://doi.org/10.15585/mmwr.mm6914e4
5. Dong Y, Mo X, Hu Y, et al. Epidemiology of COVID-19 among children in China. Pediatrics 2020. Epub March 16, 2020. https://doi.org/10.1542/peds.2020-0702
6. Bialek S, Boundy E, Bowen V, et al.; CDC COVID-19 Response Team. Severe outcomes among patients with coronavirus disease 2019 (COVID-19)—United States, February 12–March 16, 2020. MMWR Morb Mortal Wkly Rep 2020;69:343–6. https://doi.org/10.15585/mmwr.mm6912e2
7. Heinzerling A, Stuckey MJ, Scheuer T, et al. Transmission of COVID-19 to health care personnel during exposures to a hospitalized patient—Solano County, California, February 2020. MMWR Morb Mortal Wkly Rep 2020;69:472–6. https://doi.org/10.15585/mmwr.mm6915e5
8. McMichael TM, Currie DW, Clark S, et al. Epidemiology of Covid-19 in a long-term care facility in King County, Washington. N Engl J Med 2020. Epub March 27, 2020. https://doi.org/10.1056/NEJMoa2005412
9. Ghinai I, Woods S, Ritger KA, et al. Community transmission of SARS-CoV-2 at two family gatherings—Chicago, Illinois, February–March 2020. MMWR Morb Mortal Wkly Rep 2020;69:446–50. https://doi.org/10.15585/mmwr.mm6915e1
10. Hamner L, Dubbel P, Capron I, et al. High SARS-CoV-2 attack rate following exposure at a choir practice—Skagit County, Washington, March 2020. MMWR Morb Mortal Wkly Rep 2020;69:606–10. https://doi.org/10.15585/mmwr.mm6919e6

Notes from the Field

Assessing the Role of Food Handlers in Hepatitis A Virus Transmission — Multiple States, 2016–2019

Megan G. Hofmeister, MD[1]; Monique A. Foster, MD[1]; Martha P. Montgomery, MD[1]; Neil Gupta, MD[1]

The United States is experiencing person-to-person outbreaks of hepatitis A in unprecedented numbers during the vaccine era (*1*). As of May 2020, 33 states had reported hepatitis A outbreaks involving approximately 32,500 cases, 19,800 (61%) hospitalizations, and 320 deaths since 2016 (*1*). These infections are spreading primarily through close contact among persons who use drugs and persons experiencing homelessness, as well as among men who have sex with men (MSM) (*2*).

During these outbreaks, hepatitis A infections occurring among food handlers have raised public alarm and resulted in calls for vaccinating all food handlers, often prompting health departments to divert limited resources away from populations at risk. However, the risk for secondary transmission from hepatitis A–infected food handlers to food establishment patrons is not well understood. To characterize this risk, a novel, structured survey was developed and conducted using Research Electronic Data Capture (REDCap) (version 9.5.13; Vanderbilt University); among 30 state health departments reporting person-to-person hepatitis A outbreaks during July 1, 2016–September 13, 2019, 29 states responded (*3*,*4*).

Twenty-six states (89.7%) submitted complete information regarding secondary transmission events associated with food handlers (Table). Among 22,825 hepatitis A outbreak cases reported from these 26 states during July 1, 2016–September 13, 2019, 871 (3.8%) were among food handlers; 587 (67.4%) hepatitis A–infected food handlers reported one or more risk factors (i.e., drug use, unstable housing or homelessness, MSM, or incarceration) during the 15–50 days before symptom onset. Associated with these 871 hepatitis A–infected food handlers were eight (0.9%) secondary transmission events (Table), which resulted in 57 secondary cases.

Eighteen of 29 states (62.1%) submitted complete information for public health response activities related to hepatitis A–infected food handlers. Among 275 cases in food handlers from these 18 states, 271 (98.5%) investigations and 63 (22.9%) public notifications took place.

Ongoing hepatitis A outbreaks have been prolonged and costly to control (*5*). These study findings indicate that the risk for secondary infection from hepatitis A–infected food handlers to food establishment patrons in these outbreaks is low (<1.0%). Therefore, public health efforts to preemptively vaccinate all food handlers would be ineffective at mitigating the current risk for person-to-person outbreaks. To optimize resources, health departments should assess the risk for secondary transmission of hepatitis A from infected food handlers on

TABLE. Hepatitis A–infected food handlers: risk factors, secondary transmission, and public health response — multiple states, 2016–2019

Characteristic (no. with available data)*	No. (%)
Hepatitis A–infected food handlers	
States submitting complete information (29)	26 (89.7)
Total outbreak-associated† cases	22,825
Outbreak-associated cases among food handlers (22,825)	871 (3.8)
Risk factors among hepatitis A–infected food handlers§	
Drug use (injection or noninjection) (871)	486 (55.8)
Unstable housing or homelessness (760)	73 (9.6)
Incarceration (646)	54 (8.4)
Men who have sex with men (416)	85 (20.4)
One or more of the above risk factors (871)	587 (67.4)
Secondary transmission¶	
Secondary transmission events to food establishment patrons directly attributed to a hepatitis A–infected food handler**,†† (871)	8 (0.9)
Number of secondary cases directly attributed to hepatitis A transmission from a hepatitis A–infected food handler to food establishment patrons	57
Proportion of outbreak-associated cases attributable to secondary cases among food establishment patrons (22,825)	57 (0.2)
Public health response	
States submitting complete information (29)	18 (62.1)
Number of hepatitis–A infected food handler investigations (275)	271 (98.5)
Investigations involving public notification (275)	63 (22.9)
Investigations where postexposure prophylaxis was offered to food establishment patrons (275)	80 (29.1)

* Not all states collected or reported complete data for each variable presented in the table.
† Outbreak-associated status is determined at the state level in accordance with each state's outbreak case definition.
§ Survey respondents were instructed to assign hepatitis A–infected food handlers to a risk category if the food handler reported the risk factor during their exposure period (i.e., the 15–50 days before first symptom onset). Individual risk factor categories are not mutually exclusive. If a hepatitis A–infected food handler reported multiple risk factors, they were counted in each applicable category. The variables "drug use (injection or noninjection)" and "at least one of the above risk factors" were complete for 26 states, 25 of 26 states reported data for "unstable housing or homelessness" and "men who have sex with men," and 24 of 26 states reported data for "incarceration."
¶ Secondary transmission was defined as hepatitis A virus transmission from an infected food handler to food establishment patrons (i.e., the patron reported consuming food prepared by an infected food handler during the applicable exposure period and did not have a more likely alternative explanation for hepatitis A infection, such as drug use or homelessness).
** A transmission event was defined as a documented occurrence of secondary transmission of hepatitis A virus from an infected food handler to at least one food establishment patron.
†† Among the eight discrete transmission events, six events (75%) resulted in three or fewer secondary cases, one resulted in 16 secondary cases, and one resulted in 26 secondary cases.

a case-by-case basis and prioritize vaccination efforts in situations where secondary transmission risk is deemed high (*6*).

Approximately two thirds of the hepatitis A–infected food handlers in this survey reported risk factors commonly associated with the current person-to-person outbreaks. This underscores the importance of vaccination strategies targeting the populations at highest risk (i.e., persons who use drugs, persons experiencing unstable housing or homelessness, MSM, and persons who are or were recently incarcerated) as the cornerstone of an effective public health response.

Acknowledgments

Staff members of state and local health departments in Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Kentucky, Louisiana, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, South Carolina, Tennessee, Utah, Virginia, Washington, and West Virginia.

Corresponding author: Megan G. Hofmeister, lxn7@cdc.gov, 404-718-5458.

[1]Division of Viral Hepatitis, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, CDC.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

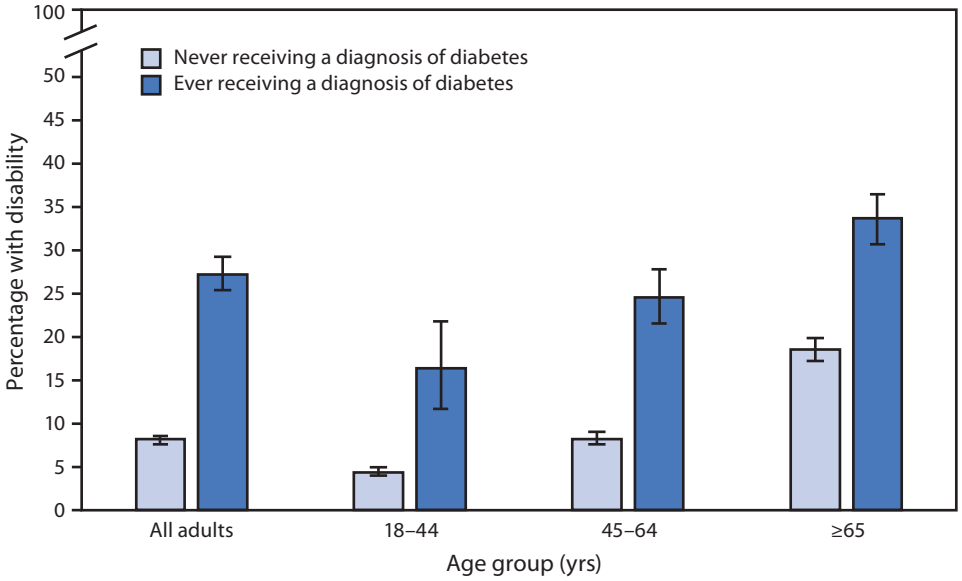
References

1. CDC. Widespread person-to-person outbreaks of hepatitis A across the United States. Atlanta, GA: US Department of Health and Human Services, CDC; 2020. https://www.cdc.gov/hepatitis/HepAOutbreak.
2. Foster MA, Hofmeister MG, Kupronis BA, et al. Increase in hepatitis A virus infections—Unitd States 2013–2018. MMWR Morb Mortal Wkly Rep 2019;68:413–5. https://doi.org/10.15585/mmwr.mm6818a2
3. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009;42:377–81. https://doi.org/10.1016/j.jbi.2008.08.010
4. Harris PA, Taylor R, Minor BL, et al.; REDCap Consortium. The REDCap Consortium: building an international community of software platform partners. J Biomed Inform 2019;95:103208. https://doi.org/10.1016/j.jbi.2019.103208
5. Bownds L, Lindekugel R, Stepak P. Economic impact of a hepatitis A epidemic in a mid-sized urban community: the case of Spokane, Washington. J Community Health 2003;28:233–46. https://doi.org/10.1023/A:1023981924010
6. Fiore AE. Hepatitis A transmitted by food. Clin Infect Dis 2004;38:705–15. https://doi.org/10.1086/381671

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Adults Aged ≥18 Years with Disability,† by Diagnosed Diabetes Status§ and Age Group — National Health Interview Survey,¶ United States, 2018



* With 95% confidence intervals indicated with error bars.
† Disability is defined by the reported level of difficulty to questions about six domains of functioning: "Do you have any difficulty…seeing, even if wearing glasses; hearing, even if wearing hearing aids; walking or climbing stairs; communicating, for example understanding or being understood; remembering or concentrating; and self-care, such as washing all over or dressing." Response categories are "no difficulty," "some difficulty," "a lot of difficulty," or "cannot do at all." Adults who respond "a lot of difficulty" or "cannot do at all" to at least one domain are classified as having disability.
§ Diabetes status was determined by a positive response to the survey question "Have you ever been told by a doctor or other health professional that you have diabetes or sugar diabetes?" Women were asked not to include diabetes occurring during pregnancy.
¶ Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population aged ≥18 years and are derived from the National Health Interview Survey Sample Adult component.

In 2018, among adults aged ≥18 years, those ever receiving a diagnosis of diabetes were more likely to have disability than those never receiving a diagnosis of diabetes (27.1% versus 8.1%). This pattern was consistent among adults aged 18–44 (16.3% versus 4.4%), 45–64 (24.5% versus 8.1%), and ≥65 years (33.3% versus 18.5%). Regardless of diabetes status, the percentage of adults with disability increased with age.

Source: National Health Interview Survey, 2018. https://www.cdc.gov/nchs/nhis.htm.

Reported by: Nazik Elgaddal, MS, nelgaddal@cdc.gov, 301-458-4538; Julie D. Weeks, PhD.

The *Morbidity and Mortality Weekly Report (MMWR)* Series is prepared by the Centers for Disease Control and Prevention (CDC) and is available free of charge in electronic format. To receive an electronic copy each week, visit *MMWR* at *https://www.cdc.gov/mmwr/index.html*.

Readers who have difficulty accessing this PDF file may access the HTML file at *https://www.cdc.gov/mmwr/index2020.html*. Address all inquiries about the *MMWR* Series, including material to be considered for publication, to Executive Editor, *MMWR* Series, Mailstop E-90, CDC, 1600 Clifton Rd., N.E., Atlanta, GA 30329-4027 or to mmwrq@cdc.gov.

ISSN: 0149-2195 (Print)