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Clusters of Rapid HIV Transmission Among Gay, Bisexual, and Other Men Who Have Sex with Men — United States, 2018–2021

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Gay, bisexual, and other men who have sex with men (MSM) accounted for 68% of new HIV diagnoses in the United States in 2020* (*1*). Despite advances in treatment and prevention, HIV transmission among MSM continues, in part because of stigma and barriers to accessing prevention and treatment services (*2*). HIV cluster detection and response, a core strategy of the Ending the HIV Epidemic in the United States initiative,† is an important tool for early identification and response to rapid HIV transmission, including among MSM. To better understand rapid HIV transmission among this population, CDC characterized large HIV molecular clusters detected using analysis of HIV-1 nucleotide sequence data from the National HIV Surveillance System (NHSS).§ Among 38 such clusters first detected during 2018–2019 that had grown to include more than 25 persons by December 2021, 29 occurred primarily among MSM. Clusters primarily among MSM occurred in all geographic regions, and 97% involved multiple states. Clusters were heterogeneous in age, gender identity, and race and ethnicity and had rapid growth rates (median = nine persons added per year). The overall transmission rate at cluster detection was 22 transmission events per 100 person-years, more than six times that of previously estimated national transmission rates (*3*). Most clusters of rapid HIV transmission occur among MSM. Swift response to reach diverse persons and communities with early, tailored, and focused interventions is essential to reducing HIV transmission (*4*).

Each calendar quarter, CDC analyzes HIV-1 polymerase (*pol*) sequences that are generated from routine HIV drug resistance testing as part of standard of care and reported to NHSS, to detect and notify jurisdictions of molecular clusters that are indicative of closely related transmission events and rapid transmission. Among persons with HIV infection diagnosed during the most recent 3 years, clusters are inferred using a pairwise threshold of 0.005 nucleotide substitutions per site; clusters of rapid transmission are those with five or more diagnoses during the most recent 12 months (*5*). Clusters first detected during 2018–2019 were examined, and large clusters were defined as those that had grown to include more than 25 persons as of December 2021. Each cluster was categorized according to the primary transmission category for persons in

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

* Includes infections attributed to male-to-male sexual contact only.
† https://www.cdc.gov/hiv/library/reports/hiv-surveillance.html
§ https://www.hiv.gov/federal-response/ending-the-hiv-epidemic/key-strategies

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the cluster.[¶] To better understand rapid transmission among MSM, further analysis was restricted to large clusters primarily involving MSM. Data reported through December 2021 were analyzed to describe these cluster characteristics and growth.

Demographic characteristics, transmission category,[**] and geographic information (U.S. Census Bureau region[††] and CDC's National Center for Health Statistics Urban-Rural Classification Scheme for Counties[§§]) were described for all persons and clusters. Annual growth rates were calculated as the increase in the number of persons in each cluster divided by the number of years between date of detection and December 2021. For clusters primarily comprising subtype B sequences,[¶¶] previously established methods were used to estimate HIV transmission rates at the time of cluster detection[***] (*5*); transmission rates were reported as the number of transmission events per 100 person-years. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[†††]

Among 136 HIV molecular clusters with rapid transmission first detected during 2018–2019, 38 (28%) clusters exceeded 25 persons by December 2021; these 38 clusters accounted for 1,533 (53%) of all 2,901 persons in the 136 molecular clusters. At that time, 29 (76%) of the 38 clusters primarily involved MSM, six (16%) primarily involved persons who inject drugs, and three (8%) had no identified primary transmission category.

The 29 large clusters primarily among MSM included 985 persons, 52% of whom were aged 20–29 years at HIV diagnosis; 91% were male (Table 1). Thirty-four percent were Black

[¶] Clusters primarily among MSM are defined as those in which more than 50% of persons were cisgender men (i.e., assigned male gender at birth and currently identify as male) who had a transmission category of male-to-male sexual contact. Clusters primarily among persons who inject drugs are defined as those in which more than 50% of persons had a transmission category of injection drug use. Clusters with no primary transmission category are defined as those in which no single transmission category was common in more than 50% of persons in the cluster.

[**] Male-to-male sexual contact, injection drug use, male-to-male sexual contact and injection drug use, heterosexual contact, perinatal, or other. https://www.cdc.gov/hiv/library/reports/hiv-surveillance/vol-32/content/technical-notes.html

[††] https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

[§§] https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

[¶¶] Subtypes, also called clades, are phylogenetically linked strains. HIV transmission rate methods rely on a subtype-specific substitution rate; these methods were only applied to the 23 clusters comprising subtype B sequences because subtype B is the most common HIV clade in the United States. The remaining six clusters primarily consisted of sequences from subtypes G and A, or sequences not able to be assigned a subtype.

[***] Transmission rates at the time of cluster detection were estimated as the number of transmission events in a cluster, divided by the total time that persons in the cluster were living with HIV infection (i.e., the interval between the estimated date of infection and the date the cluster was detected in the analysis period). The number of transmission events in each cluster was calculated as the number of persons in the cluster minus one. To assess total time persons in the cluster were living with HIV infection, molecular clock phylogenetic analysis was used to estimate node ages or the time since transmission events connecting persons in the cluster.

[†††] 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq. Section 318(b-c) of the Public Health Service Act (42 USC Sect. 247c[b-c]), as amended, and the Consolidated Appropriation Act of 2016 (Pub. L. 114–113).

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or African American (Black) persons; 29% were Hispanic or Latino (Hispanic), and 29% were White. The most common transmission category was male-to-male sexual contact (MMSC) (77%); an additional 5% of persons reported MMSC and injection drug use.

Approximately one half (48%) of persons in these 29 clusters lived in the South U.S. Census Bureau region, followed by 31% in the West, and 15% in the Northeast; 5% lived in the Midwest. Overall, 70% of persons lived in large central metropolitan or large fringe metropolitan areas at the time of HIV infection diagnosis, and 20% lived in medium metropolitan areas.

As of December 2021, Black persons accounted for the largest racial or ethnic group in 13 (45%) large clusters among MSM, followed by White persons in nine (31%) clusters and Hispanic persons in seven (24%) (Table 2). In 14 (48%) clusters, the most common U.S. Census Bureau region was the South; 23 (79%) clusters included persons from more than one region. In 19 (66%) clusters, the most common area of residence was large central metropolitan; the second most common was medium metropolitan (seven clusters; 24%). Twenty-eight (97%) clusters involved persons in multiple states (median = four states; IQR = three to six states).

Median cluster size at the time of detection was 11 persons (IQR = 8–12); median size as of December 2021 was 32 persons (IQR = 27–38) (Figure). Median annual growth rate was nine persons per year (IQR = six to 11). Among 23 subtype B clusters, transmission rates ranged from 11 to 140 transmission events per 100 person-years (IQR = 21–31); the transmission rate across all subtype B clusters was 22 transmission events per 100 person-years.

TABLE 1. Characteristics of persons in large HIV clusters primarily among gay, bisexual, and other men who have sex with men (N = 29) — United States, 2021*

Characteristic	No. (%) of persons
Total	**985 (100.0)**
Age group at HIV diagnosis, yrs	
13–19	104 (10.6)
20–29	515 (52.3)
30–39	237 (24.1)
40–49	74 (7.5)
50–59	49 (5.0)
≥60	6 (0.6)
Gender identity†	
Male	898 (91.2)
Female	41 (4.2)
Transgender woman	41 (4.2)
Transgender man	4 (0.4)
Additional gender identity	1 (0.1)
Race and ethnicity§	
Black or African American	338 (34.3)
Hispanic or Latino	289 (29.3)
White	285 (28.9)
Multiracial	52 (5.3)
Asian	15 (1.5)
American Indian or Alaska Native	4 (0.4)
Native Hawaiian or other Pacific Islander	2 (0.2)
Transmission category¶	
Male-to-male sexual contact	759 (77.1)
Other or no identified risk	104 (10.6)
Heterosexual contact	49 (5.0)
Male-to-male sexual contact and injection drug use	44 (4.5)
Injection drug use	29 (2.9)
U.S. Census Bureau region**	
Northeast	149 (15.1)
Midwest	53 (5.4)
South	473 (48.0)
West	310 (31.5)
Urbanicity††	
Large central metro	516 (52.4)
Large fringe metro	178 (18.1)
Medium metro	193 (19.6)
Small metro	48 (4.9)
Micropolitan (nonmetro)	27 (2.7)
Noncore (nonmetro)	17 (1.7)
Missing urbanicity	6 (0.6)

* Includes molecular clusters first detected during 2018–2019 that included 25 or more persons as of December 2021 and for which more than 50% of persons were cisgender men (i.e., assigned male at birth and currently identify as male) who had a transmission category of male-to-male sexual contact.
† Transgender woman includes persons assigned male sex at birth who identify as female. Transgender man includes persons assigned female sex at birth who identify as male. Additional gender identity includes persons assigned male or female at birth who do not identify as male, female, transgender woman, or transgender man and includes bigender, genderqueer, and two-spirit.
§ Hispanic or Latino persons can be of any race.
¶ Transmission category is classified based on a hierarchy of the risk factors most likely responsible for HIV transmission; classification is determined based on the person's sex assigned at birth. Other risk factors include perinatal, hemophilia, and blood transfusion.
** https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf
†† https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

Discussion

This analysis found that most large clusters of rapid HIV transmission in the United States occur primarily among MSM. Such clusters were characterized by rapid growth and transmission rates more than six times those of previously estimated national rates (*3*).

The presence of an HIV cluster indicates a failure of treatment and prevention services to reach certain communities. HIV cluster detection and response activities can quickly identify rapid HIV transmission, including among MSM, and support early interventions that increase access to prevention and care services and improve health outcomes. These interventions should improve access and strengthen linkages to HIV testing, preexposure prophylaxis, and timely HIV treatment. Most clusters in this analysis were small at the time of detection, indicating an opportunity for these early interventions to uncover and address gaps in HIV services, remove any barriers

TABLE 2. Characteristics of large HIV clusters primarily among gay, bisexual, and other men who have sex with men,* by quarter — United States, 2018–2021

					As of Dec 2021 (% of persons in cluster)			
Quarter detected,† cluster no.	No. of persons at detection	No. of persons as of Dec 2021	Annual growth rate§	Transmission rate at detection¶	Most prevalent age group at diagnosis, yrs	Largest racial and ethnic group**	Most common region††,§§	Most common urbanicity††,¶¶
2018 Q1								
1	11	30	5	20	30–39 (40)	Hispanic (50)	West (100)	Medium metro (70)
2	7	35	7	21	30–39 (31)	Hispanic (51)	South (86)	Large central metro (49)
3	9	27	5	—***	20–29 (52)	Black (63)	Northeast (93)	Large central metro (78)
2018 Q2								
4	6	27	6	36	20–29 (65)	Black (63)	West (74)	Large central metro (70)
5	9	40	9	50	20–29 40)	Black (35)	Northeast (88)	Large central metro (50)
2018 Q3								
6	17	56	12	25	20–29 (57)	White (88)	South (80)	Medium metro (54)
7	11	29	6	20	20–29 (53)	White (41)	South (79)	Large central metro (66)
2018 Q4								
8	12	38	9	26	20–29 (58)	Black (50)	South (71)	Large fringe metro (55)
9	14	32	6	39	20–29 (63)	White (75)	South (81)	Large central metro (75)
10	12	46	11	—***	20–29 (48)	White (35)	South (98)	Large central metro (74)
11	5	39	11	45	20–29 (51)	Hispanic (44)	Northeast (72)	Large central metro (49)
2019 Q1								
12	11	43	14	14	20–29 (44)	Hispanic (88)	West (100)	Large central metro (65)
13	11	33	10	23	20–29 (46)	Black (52)	Midwest (76)	Medium metro (48)
14	6	42	16	—***	20–29 (71)	Black (52)	West (90)	Large central metro (98)
15	9	34	11	22	20–29 (71)	Black (71)	South (94)	Large central metro (68)
16	6	30	11	43	20–29 (73)	Black (87)	South (100)	Medium metro (57)
17	15	36	9	23	13–19 (67)	Black (94)	South (94)	Large central metro (67)
18	9	27	8	—***	30–39 (41)	Hispanic (89)	South (100)	Large central metro (89)
19	15	26	5	21	20–29 (81)	Black (89)	South (100)	Small metro (62)
2019 Q2								
20	12	31	8	11	20–29 (77)	White (55)	West (94)	Large central metro (81)
21	8	29	8	15	30–39 (38)	Hispanic (86)	West (100)	Large central metro (97)
22	10	32	9	23	20–29 (47)	Hispanic (66)	West (97)	Medium metro (91)
23	16	26	4	23	20–29 (50)	Black (81)	South (96)	Large fringe metro (35) and medium metro (35)
2019 Q3								
24	5	37	14	140	30–39 (32)	White (81)	West (97)	Large central metro (51)
25	8	26	8	21	20–29 (54)	White (58)	Northeast (58)	Large central metro (62)
2019 Q4								
26	14	37	11	—***	20–29 (73)	Black (54)	West (86)	Large central metro (68)
27	9	44	17	—***	20–29 (43)	White (43)	South (95)	Large fringe metro (59)
28	11	27	8	25	20–29 (56)	Black (93)	South (81)	Large central metro (81)
29	19	26	3	21	20–29 (50)	White (69)	Northeast (96)	Medium metro (69)

Abbreviations: Q1 = quarter 1; Q2 = quarter 2; Q3 = quarter 3; Q4 = quarter 4.

* Includes molecular clusters first detected during 2018–2019 that included 25 or more persons as of December 2021 and for which more than 50% of persons were cisgender men (i.e., assigned male at birth and currently identify as male) who had a transmission category of male-to-male sexual contact.

† Q1: January–March, Q2: April–June, Q3: July–September, Q4: October–December.

§ Persons per year, calculated as the total number of cases added between the quarter of initial detection through December 2021, divided by the total years between initial detection and December 2021.

¶ Transmission events per 100 person-years estimated as the number of transmission events in a cluster, divided by the total time that persons in the cluster were living with HIV.

** Hispanic persons could be of any race.

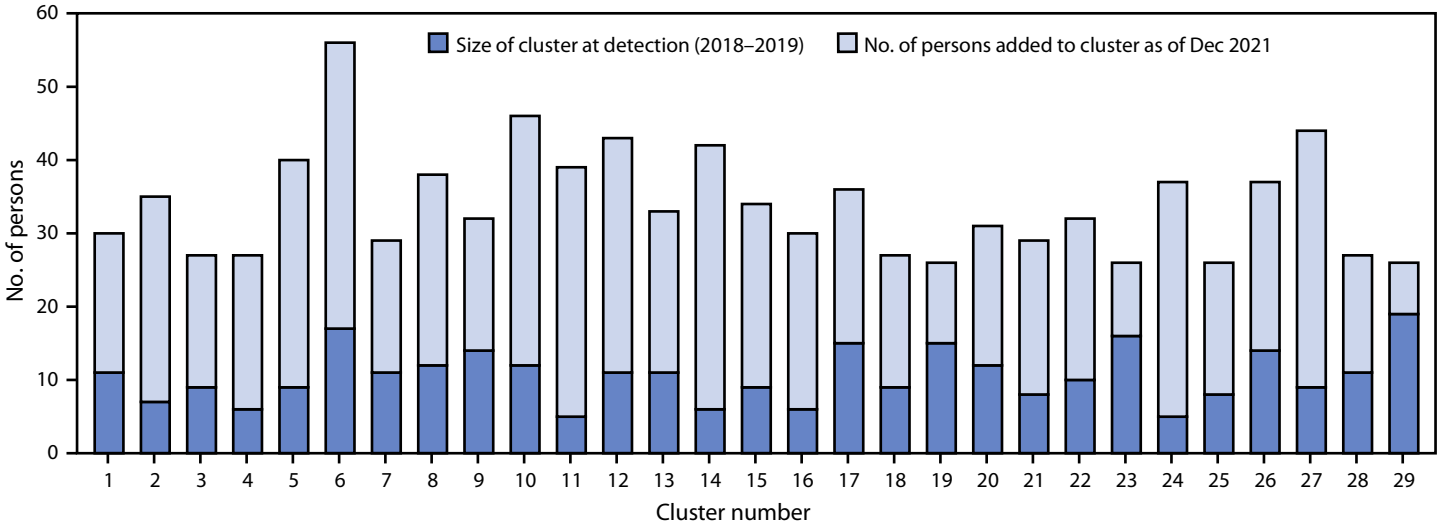
†† Based on residence at time of diagnosis.

§§ https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

¶¶ https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

*** Subtypes are phylogenetically linked strains. Dashes indicate clusters composed primarily of persons with nonsubtype B sequences; transmission rates were not calculated for these clusters. HIV transmission rate methods use a subtype-specific substitution rate; these methods are only applied to the 23 clusters made up of subtype B sequences.

FIGURE. Increase in size of large HIV clusters primarily among gay, bisexual, and other men who have sex with men — United States, 2018–2021*



* Clusters were detected during 2018–2019 and do not all have the same follow-up time from detection to December 2021.

to those services, and interrupt rapid transmission among MSM and others.

A recent analysis indicated that the characteristics of persons in HIV molecular clusters can vary geographically and over time, and that molecular analysis identifies rapid transmission that might not be evident from other surveillance data (*6*). In this analysis, the disproportionate representation of Black and Hispanic MSM in these clusters mirrored disparities observed in national HIV surveillance data (*1*); however, the identification of clusters of rapid transmission provides a more local and nuanced understanding of diverse communities of MSM experiencing rapid transmission within larger heterogenous populations (e.g., all MSM). In addition to race and ethnicity, this analysis also identified variations in other characteristics of persons in large clusters primarily among MSM. While most persons in these clusters were cisgender men who reported MMSC, individual clusters also included transgender persons and persons who inject drugs. Health departments detecting and responding to these clusters can rapidly use data ascertained through cluster detection activities,§§§ as well as existing data sources (e.g., partner services data, other communicable disease surveillance data, and behavioral surveillance¶¶¶) or supplementary data collection (e.g., rapid needs assessments, qualitative interviews, and medical record abstraction), to better and more quickly understand affected populations and identify service gaps experienced by persons in these clusters (*4*,*7*). Gathering additional quantitative or qualitative data is important to understand and address the differing needs of persons in networks experiencing rapid transmission, including sexual, gender, and racial and ethnic minority groups involved in each cluster.

These cluster-specific data can guide the rapid implementation of response interventions (*4*). For example, clusters involving both Black and Hispanic MSM would benefit from interventions that address the unique needs and barriers faced by each group, rather than more generalized response activities aimed at broader MSM groups. Further, for clusters that primarily involve MSM but also include persons who inject drugs, response interventions should include activities to prevent both sexual and injection-related transmission. Persons involved in the clusters represented in this analysis vary in their prevention and treatment needs, barriers to accessing services, and experiences of stigma and discrimination (*4*,*7*); a single intervention is unlikely to be appropriate for all cluster responses, or for all persons within a cluster.

Clusters were detected in all regions of the country, and many included persons from multiple states, indicating the need for state and local health departments to be equipped to quickly detect and respond to clusters and collaborate with other health departments to address multistate clusters when indicated. CDC provides quarterly notification to jurisdictions about clusters of rapid transmission and supports health departments

§§§ Jurisdictions are expected to conduct molecular analysis using their HIV surveillance data each month to detect HIV molecular clusters. These jurisdictions are supported in these analyses by programs made available by CDC and can detect, analyze, and visualize clusters using a bioinformatics tool called Secure HIV-TRACE. https://www.cdc.gov/hiv/funding/announcements/ps18-1802/guidance-relateds.html

¶¶¶ https://www.cdc.gov/hiv/statistics/systems/nhbs/index.html

with guidance, tools, and technical assistance to implement cluster detection activities and build response programs**** that address the needs of MSM and others affected by HIV in their communities.

The findings in this report are subject to at least four limitations. First, incomplete HIV sequence reporting affects local and national cluster detection and characterization (*8*). Sequences were reported for approximately one half of diagnosed infections in recent years (*6*). Second, delays in sequence reporting can result in delayed cluster detection, artificially lowering estimates of growth rates for some clusters. Third, because sequences are available only for persons who have received an HIV diagnosis and entered care, persons in molecular clusters typically represent only a fraction of those in underlying transmission networks or in social networks who might have increased chances of acquiring HIV (*4*). Finally, this analysis does not include all clusters detected using other methods (*4*).

Most large, rapidly growing HIV clusters occur primarily among MSM. Leveraging cluster data to rapidly identify and implement interventions when clusters are first detected is essential to stopping transmission. Many MSM face barriers to accessing HIV services because of stigma, homophobia, racism, xenophobia, poverty, and limitations in health insurance†††† (*1*,*2*). Successful response interventions should aim to eliminate these barriers, quickly close service gaps, and address existing and emerging syndemics affecting MSM, including sexually transmitted infections and monkeypox (*9*). When mobilized effectively, strategies that engage communities, improve prevention services, and strengthen linkage to care can address the needs of persons in HIV clusters.§§§§ Understanding the diverse populations affected by HIV clusters among MSM is necessary to implementing tailored and robust response interventions, stopping transmission, and preventing new HIV infections in this population.

**** https://www.cdc.gov/hivcluster
†††† https://www.cdc.gov/msmhealth/index.htm
§§§§ https://www.cdc.gov/hiv/policies/cdr/spotlights/texas.html

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Summary

What is already known about this topic?

HIV molecular cluster detection and response activities identify communities in which rapid transmission is occurring and help guide public health action.

What is added by this report?

Most large HIV molecular clusters of rapid transmission occurred among gay, bisexual, and other men who have sex with men (MSM). These clusters occurred in all regions of the country, grew rapidly, and varied in demographic characteristics, including race and ethnicity.

What are the implications for public health practice?

Responding swiftly to clusters is important to interrupting transmission. Understanding the diverse populations in HIV clusters among MSM is necessary for implementing tailored and robust response interventions, improving prevention and care services, and stopping transmission in affected communities.

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Outbreak of Acute Gastroenteritis Among Rafters and Backpackers in the Backcountry of Grand Canyon National Park, April–June 2022

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On May 11, 2022, the National Park Service (NPS) Office of Public Health (OPH) and Coconino County Health and Human Services (CCHHS) in Flagstaff, Arizona contacted CDC about a rising number of acute gastroenteritis cases among backcountry visitors to Grand Canyon National Park (Grand Canyon). The agencies reviewed illness report forms, assessed infection prevention and control (IPC) practices, and distributed a detailed survey to river rafters and hikers with backcountry permits (backpackers) who visited the Grand Canyon backcountry. During April 1–June 17, a total of 191 rafters and 31 backpackers reported symptoms consistent with acute gastroenteritis. Specimens from portable toilets used by nine river rafting trip groups were tested using real-time reverse transcription–polymerase chain reaction and test results were positive for norovirus. Norovirus-associated acute gastroenteritis is highly transmissible in settings with close person-to-person contact and decreased access to hand hygiene, such as backpacking or rafting. IPC assessments led to recommendations for regular disinfection of potable water spigots throughout the backcountry, promotion of proper handwashing with soap and water when possible, and separation of ill persons from those who are not ill. Prevention and control of acute gastroenteritis outbreaks in the backcountry requires rapid reporting of illnesses, implementing IPC guidelines for commercial outfitters and river rafting launch points, and minimizing interactions among rafting groups.

Commercially operated Colorado River rafting trips are allowed within the Grand Canyon during April–October (*1*). OPH surveillance of river rafting trip illnesses requires that guides on commercially operated trips report the occurrence of fewer than three illnesses at each trip's end, contact the NPS by satellite phone as soon as possible when three or more illnesses occur (*2*), and complete an illness report form for each ill person. Private rafting trip guides must report illnesses within 7 days after completing the trip (*3*). Backpackers are encouraged to report illnesses.

During April–May 2022, approximately 4,770 rafters visited the Grand Canyon backcountry.† On April 8, 2022, OPH was notified by a commercially operated rafting group within Grand Canyon of seven persons experiencing vomiting or diarrhea. After nine additional rafting trips (173 rafters), multiple cases of acute gastroenteritis were reported. OPH and CCHHS contacted CDC on May 11, 2022. By May 21, thirteen additional rafting trips with 102 reported cases of acute gastroenteritis were documented, and several backpackers reported symptoms consistent with acute gastroenteritis. A specific source of virus transmission had not been identified. On May 24, 2022, NPS requested CDC assistance, and an investigation was initiated.

A case of acute gastroenteritis was defined as vomiting or diarrhea (at least three loose stools during a 24-hour period) <24 hours before trip launch through 3 days after the end of the trip in a person who participated in a river rafting trip or backcountry backpacking in the Grand Canyon during April 1–June 17, 2022. A detailed survey was distributed by email to all backpackers, river rafters on private and commercially operated trips with one or more ill persons, and river rafters on commercial trips with no reported ill persons during the same period. Survey responses were linked to illness report forms of previously reported illnesses to deduplicate. The survey closed on July 8, 2022. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.§

Among 116 illness report forms collected through July 8, 2022, a total of 94 (81%) rafters reported vomiting, 79 (68%) reported diarrhea, and 74 (64%) reported nausea. Acute onset, short symptom duration (median 24 hours), and predominance of vomiting suggested norovirus. CCHHS coordinated with the University of Arizona to test portable toilets for norovirus using real-time reverse transcription–polymerase chain reaction (*4*) with specimens from nine affected rafting trips and two unaffected trips. Pooled portable toilet specimens from each of the nine affected trips were positive for norovirus, including two specimens from river rafting trips that started in April 2022 (genotype 1) and seven specimens from river rafting trips that started in May 2022 (genotype 2). None of the pooled specimens from the portable toilets used during

*These authors contributed equally to this report.

†https://grcariverpermits.nps.gov/viewRiverCalendars.cfm (Accessed September 20, 2022).

§45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

the two unaffected trips tested positive for norovirus. Portable toilet specimens were not tested for other pathogens.

The date of first illness onset among rafters was April 6, 2022; the trip had an attack rate of 39% (11 of 28 rafters). Rafting trip attack rates ranged from 10% (three of 31) to 83% (29 of 35). During April 1–June 17, 2022, a total of 222 persons had an illness that met the case definition for acute gastroenteritis (Table) (Figure). Most respondents reported illness onset during the trip (178; 80%), with five persons from separate trips (two river rafters and three backpackers) reporting illness onset <24 hours before their trip started (different illness onset dates). Most cases occurred among park visitors (191; 86%) and the remaining cases (31; 14%) among professional guides.[¶] Ill visitors were from 34 U.S. states and four additional countries. Among 222 acute gastroenteritis cases, 160 (72%) persons completed the electronic survey and provided sufficient information for further analysis (Table). Most (73%) illness onsets occurred during May 1–20, 2022. Survey response collection ended on July 8, 2022, with 1,327 visitors to the

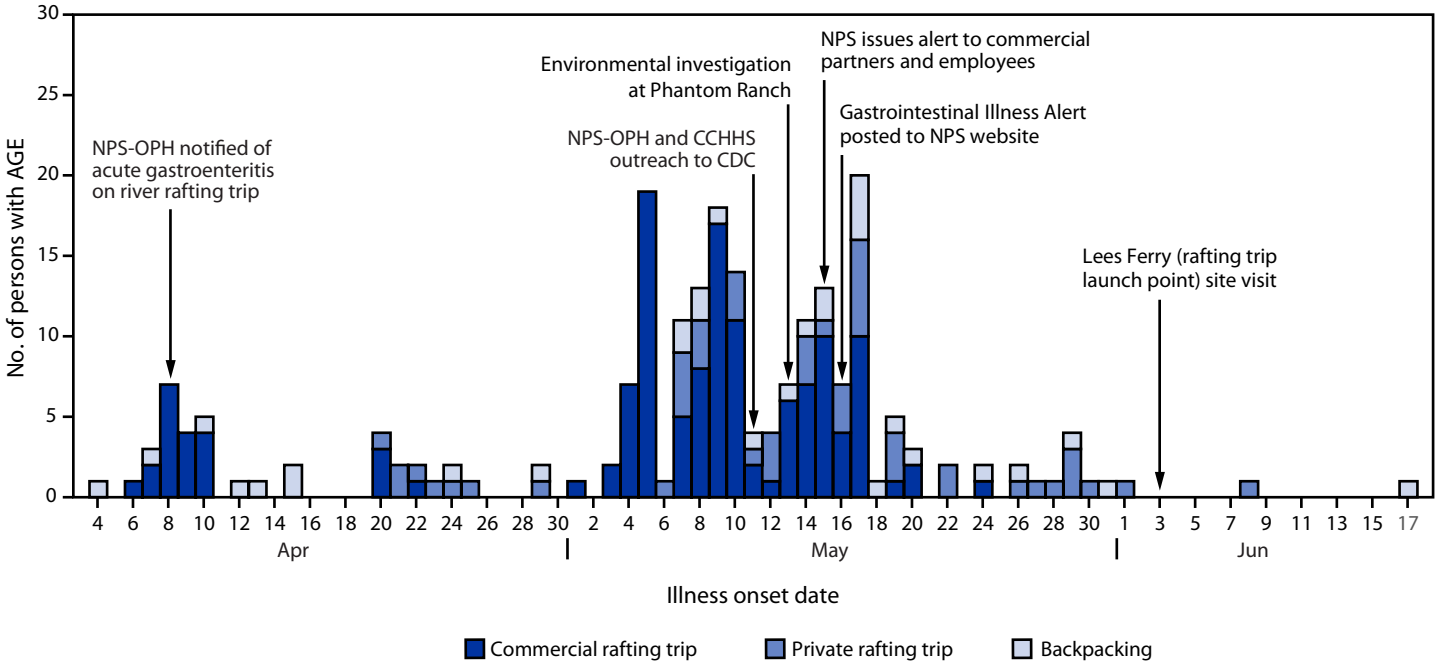
[¶] All cases among guides occurred after illness onset among rafters on the same trip.

TABLE. Characteristics of park visitors and guides with acute gastroenteritis (N = 222), by type of activity — Grand Canyon National Park, April 1–June 17, 2022

Characteristic	No. (%)		
	Commercial rafting trip*	Private rafting trip	Backpacking
Persons with an illness report form or completed survey			
Total	**136**	**55**	**31**
Age, yrs, median, (IQR)	55 (36–64)	39 (33–60)	40 (30–52)
Gender			
Female	65 (48)	20 (36)	12 (39)
Male	69 (51)	34 (62)	19 (61)
Nonbinary	1 (<1)	0 (—)	0 (—)
Did not specify	1 (<1)	1 (<1)	0 (—)
Symptom onset			
≤24 hrs before trip began	2 (<1)	0 (—)	3 (10)
During the trip	113 (83)	49 (89)	16 (52)
≤3 days after trip end	21 (15)	6 (11)	12 (39)
National Park user type			
Guide	30 (22)	0 (—)	1 (3)
Park visitor	106 (78)	55 (100)	30 (97)
Persons who completed survey			
Total[†]	**78**	**51**	**31**
Age, yrs, median (IQR)	57 (40–65)	39 (33–60)	40 (30–52)
Race[§]			
White	74 (95)	50 (98)	29 (94)
Asian, NH/OPI, or Other	3 (4)	0 (—)	2 (6)
Did not specify	1 (1)	1 (2)	0 (—)
Ethnicity			
Hispanic or Latino	1 (1)	1 (2)	3 (10)
Not Hispanic or Latino	73 (94)	46 (90)	27 (87)
Did not specify	4 (5)	4 (8)	1 (3)
Symptom duration, median hours (IQR)	24 (22–36)	24 (12–48)	24 (12–72)
Reported interactions with persons from other trips			
Yes	29 (37)	40 (78)	NA[¶]
No	49 (63)	11 (22)	NA
Did not specify	0 (—)	0 (—)	NA
Reported interactions with ill, suspected ill, or symptomatic persons**			
Yes	53 (68)	29 (57)	NA
No	25 (32)	22 (43)	NA
Did not specify	0 (—)	0 (—)	NA

Abbreviations: NA = not applicable; NH/OPI = Native Hawaiian or other Pacific Islander.
* Includes persons who completed an illness report form or electronic survey.
† Includes only persons who completed electronic survey via email distribution.
§ None of the respondents identified as Black or African American or as American Indian or Alaska Native.
¶ Backpackers in the backcountry did not receive these questions.
** Reports of interactions with ill, suspected ill, or symptomatic persons might include persons on the same trip as the respondent.

FIGURE. Number of persons with acute gastroenteritis among rafters and backpackers (N = 222*), by illness onset date — Grand Canyon National Park, April 1–June 17, 2022



Abbreviations: AGE = acute gastroenteritis; CCHHS = Coconino County Health and Human Services; NPS = National Park Service; NPS-OPH = National Park Service Office of Public Health.
* Five rafters on private rafting trips were excluded because they reported insufficient information on date of illness onset.

Grand Canyon backcountry completing at least a portion of the survey. Further analysis is underway to examine epidemiologic overlap among ill and non-ill rafters and backpackers who completed the survey.

Public health partners shared norovirus IPC education messages tailored to the backcountry environment immediately after notification (Figure). This included recommendations for symptom screening and exclusion of ill-persons from joining a rafting trip, disinfection of potable water, separation of ill persons from healthy persons, enhanced environmental cleaning, and strict precautions for food storage and preparation on river rafts in addition to environmental inspections of the commercial outfitters' warehouses. OPH staff members conducted a site visit at Phantom Ranch** (a common exchange point) on May 13, 2022, and made recommendations for daily disinfection of the two potable water spigots using a chlorine solution and placement of mechanical backflow prevention devices between animal drinking trough hoses and potable water supply hoses. Frequent communication occurred among commercial outfitters, the backcountry office, and public health agencies to expedite information exchange, including the sharing of portable toilet test results.

NPS posted multiple acute gastroenteritis website alerts†† to provide prevention education beginning on May 16, 2022, including a link to CDC's *Norovirus* and *Safe Drinking Water* webpages.§§ Outfitter staff members were advised to promote handwashing with soap and water, monitor adherence, and isolate or cohort persons with acute gastroenteritis during the trip whenever possible. Many outfitter staff members were unaware that alcohol-based hand sanitizer is ineffective in mitigating norovirus transmission (*5*). OPH and CDC conducted a site visit to the Lees Ferry raft launch point on June 3, 2022 and recommended adding signs to promote handwashing in restrooms, displaying acute gastroenteritis outbreak information on bulletin boards throughout the backcountry, and increasing the frequency of cleaning restrooms and disinfecting the potable water spigot, a highly used water source by rafters and day visitors.

** https://www.nps.gov/grca/learn/photosmultimedia/grand-canyon-in-depth-03.htm

†† https://www.nps.gov/grca/planyourvisit/conditions.htm
§§ https://www.cdc.gov/healthywater/drinking/travel/index.html

Discussion

A large norovirus-associated outbreak of acute gastroenteritis occurred in the Grand Canyon backcountry among river rafters and backpackers during April–June 2022. Preliminary analyses of illness characteristics and portable toilet specimen test results suggested norovirus as the primary causative agent of illness. Norovirus spreads quickly through person-to-person contact and contaminated food or beverages, and can persist in the environment (*5*). Five persons reported illness onset <24 hours before their trips were launched and two genotypes were identified from portable toilet specimens of affected trips, indicating a potential for multisource introduction of norovirus into the river corridor. Analyses of survey responses are underway to identify epidemiologic overlap, including food and beverages, river stop locations, backcountry toilet use, and other factors.

Illness reports slowed before the arrival of the CDC team on May 31, 2022. The close relationship among outfitters and public health authorities likely facilitated rapid communication about the rise in acute gastroenteritis cases that resulted in more vigilant warnings during pretrip passenger briefings and an internal reinforcement of environmental protection and equipment sanitation guidelines (*2*). The last report of acute gastroenteritis occurred on June 17, 2022.

The findings in this report are subject to at least two limitations. First, although no individual specimens were available for testing, test results from pooled portable toilets suggest norovirus as a primary contributor to this outbreak. Second, the total number of illnesses associated with this outbreak is likely underreported. OPH has adapted sanitation standards and IPC recommendations to meet the unique setting of river rafting and backcountry camping trips. Some acute gastroenteritis, including norovirus, is expected on rafting and hiking trips (*6*). Norovirus is highly infectious and has a low infective dose (*5*). Because many trips use the same campsites and place portable toilets in the same locations, particles could have been transmitted to surfaces, beach sand, or river water where new groups could have encountered them, and then transmitted the virus both from person-to-person and trip-to-trip. Rapid separation of ill persons from non-ill persons and reinforcement of hygiene and sanitation practices by commercial rafting trip guides might have led to lower attack rates reported on some trips.

Previous norovirus outbreaks have occurred among river rafters in Grand Canyon associated with contaminated food products (*7*) and person-to-person transmission (*8*) resulting in recommendations to adhere to strict hygiene guidance. An increase in norovirus activity was observed at a national level in spring 2022, with the number of outbreak reports returning to prepandemic levels for the first time since March 2020 (*9*).

With norovirus increasing nationwide and visitation rates returning to near prepandemic levels (*10*), the potential exists for resurgence of norovirus outbreaks among visitors to the Grand Canyon backcountry. River rafting and camping might amplify norovirus spread because of limited hygiene supplies and close person-to-person contact. Prevention and control of future outbreaks includes rapid reporting of illnesses, symptom screening before trip launch to minimize introduction of illnesses, strict adherence to hand hygiene with soap and water and sanitation protocols, disinfection of water before consumption, prompt separation of ill passengers, and minimizing of interactions with other rafting groups.

Summary

What is already known about this topic?

Norovirus-associated acute gastroenteritis is highly transmissible in settings with close person-to-person contact and decreased access to hand hygiene, such as backpacking or rafting.

What is added by this report?

During April 1–June 17, 2022, the largest outbreak of acute gastroenteritis documented in the Grand Canyon National Park backcountry occurred. At least 222 rafters and backpackers became infected, probably with norovirus. Strong partnerships with river outfitters and National Park staff members enabled implementation of prevention and control measures.

What are the implications for public health practice?

Outbreak control measures in the setting of rafting and backpacking include rapid case reporting, symptom screening before trip start, water disinfection, prompt separation of ill passengers, strict adherence to hand hygiene with soap and water, and minimizing interactions among rafting groups.

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Two Cases of Monkeypox-Associated Encephalomyelitis — Colorado and the District of Columbia, July–August 2022

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On September 13, 2022 this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

Monkeypox virus (MPXV) is an orthopoxvirus in the *Poxviridae* family. The current multinational monkeypox outbreak has now spread to 96 countries that have not historically reported monkeypox, with most cases occurring among gay, bisexual, and other men who have sex with men (*1*,*2*). The first monkeypox case in the United States associated with this outbreak was identified in May 2022 in Massachusetts (*1*); monkeypox has now been reported in all 50 states, the District of Columbia (DC), and one U.S. territory. MPXV is transmitted by close contact with infected persons or animals; infection results in a febrile illness followed by a diffuse vesiculopustular rash and lymphadenopathy. However, illness in the MPXV current Clade II outbreak has differed: the febrile prodrome is frequently absent or mild, and the rash often involves genital, anal, or oral regions (*3*,*4*). Although neuroinvasive disease has been previously reported with MPXV infection (*5*,*6*), it appears to be rare. This report describes two cases of encephalomyelitis in patients with monkeypox disease that occurred during the current U.S. outbreak. Although neurologic complications of acute MPXV infections are rare, suspected cases should be reported to state, tribal, local, or territorial health departments to improve understanding of the range of clinical manifestations of and treatment options for MPXV infections during the current outbreak.

Details of two cases of encephalomyelitis associated with monkeypox in previously healthy young gay men in Colorado and DC are presented in this report. The University of Colorado and Georgetown University determined that this report was not subject to human subjects review because it includes only information obtained for purposes of patient clinical care and public health outbreak response. This activity was also reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[†]

Patient A

The first case occurred in a previously healthy, presumedly immunocompetent gay man in his 30s in Colorado (patient A). He had no recognized MPXV exposure or recent travel. He was not previously vaccinated against monkeypox or smallpox. In July 2022, he acutely developed fever, chills, and malaise. Three days after symptom onset, an itchy vesiculopustular rash appeared on his face and spread to his extremities and scrotum during the next several days. Swabs of a lesion yielded a positive polymerase chain reaction (PCR) test result for *Orthopoxvirus* DNA, later confirmed to be MPXV DNA. Nine days after symptom onset, the patient developed progressive left upper and lower extremity weakness and numbness, urinary retention, and intermittent priapism, and was hospitalized. Magnetic resonance imaging (MRI) of the brain showed partially enhancing lesions in the frontal lobes consistent with demyelination as well as nonenhancing lesions of the bilateral basal ganglia, bilateral medial thalami, splenium, and pons (Figure 1). MRI of the spine showed multifocal, longitudinally extensive, partially enhancing lesions of the central thoracic spinal cord and gray matter of the conus medullaris, with a single cervical level of canal stenosis with partial cord compression (presumably chronic and not acute). Cerebrospinal fluid (CSF) analysis demonstrated 155 white blood cells/μL (normal = ≤5) with 60% lymphocytes, 30% monocytes, and 10% neutrophils; 9 red blood cells/μL (normal = 0); glucose 64 mg/dL (normal = 45–80 mg/dL); and protein 273 mg/dL (normal = 15–45 mg/dL). CSF bacterial cultures were negative. CSF herpes simplex virus (HSV) and varicella zoster virus (VZV) PCR test results were negative. No CSF-specific oligoclonal bands (a marker for central nervous system [CNS] inflammation) were present. Serum aquaporin-4 (to evaluate for neuromyelitis optica spectrum disorder [NMOSD][§]) and myelin oligodendrocyte glycoprotein (MOG) (to evaluate for MOG antibody–associated disease [MOGAD][¶]) antibody

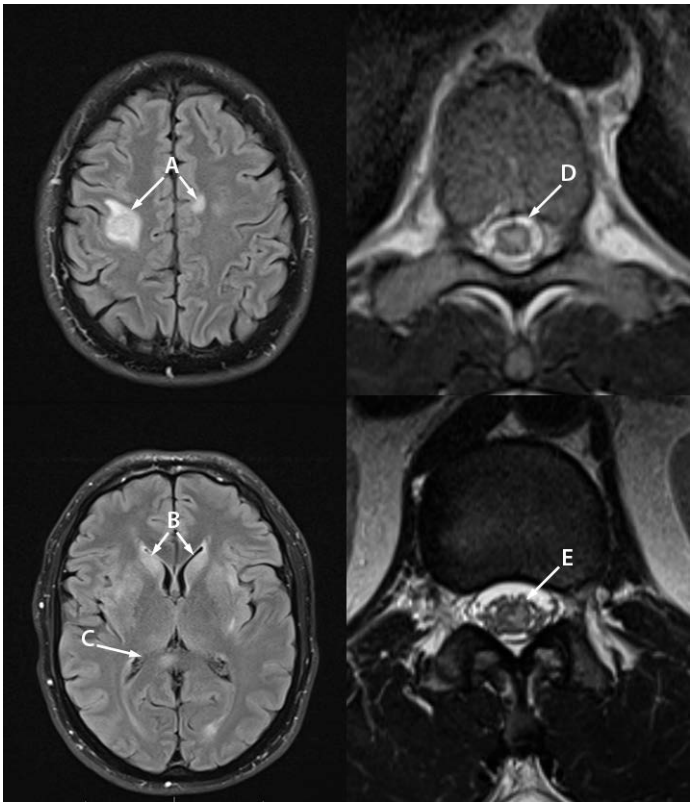
[*] These authors contributed equally to this report.

[†] 45 C.F.R. part 46.102(l)(2); 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

[§] A chronic disorder of the brain and spinal cord dominated by inflammation of the optic nerve (optic neuritis) and inflammation of the spinal cord (myelitis).

[¶] An inflammatory disorder of the central nervous system characterized by attacks of immune-mediated demyelination predominantly targeting the optic nerves, brain, and spinal cord.

FIGURE 1. Magnetic resonance imaging of the brain, thoracic spine, and conus medullaris of patient A with monkeypox-associated encephalomyelitis showing abnormal T2/fluid attenuated inversion recovery signal in the right frontal and left frontal lobes (A), bilateral basal ganglia (B), bilateral medial thalami and right splenium (C), central thoracic spinal cord (D), and gray matter of the conus medullaris (E) — Colorado, July–August 2022



Photos/Daniel M. Pastula.

test results were negative. Serum HIV serologic and PCR test results were negative. Serum treponemal antibodies and particle agglutination test results were positive; serum rapid plasma reagin (RPR) and CSF venereal disease research laboratory (VDRL) test results were negative, suggesting a past syphilis infection (patient A received a single dose of penicillin after an exposure in 2013). SARS-CoV-2 reverse transcription–PCR nasopharyngeal swab test result was negative, and serum and CSF MPXV PCR test results were negative.

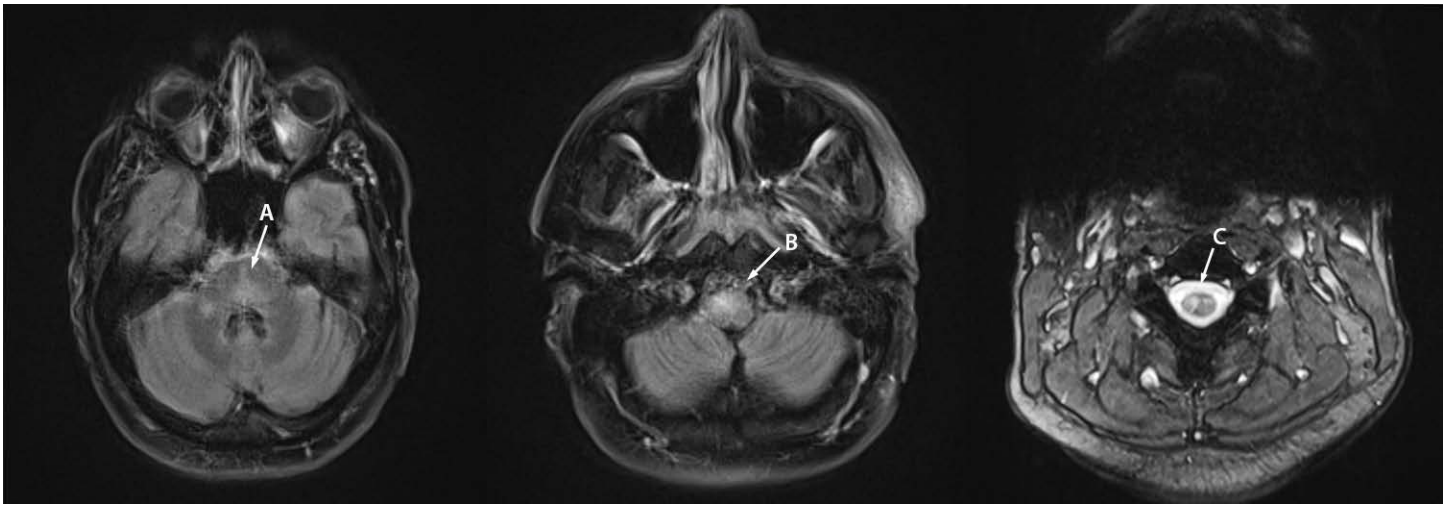
Treatment with oral tecovirimat began immediately after the onset of neurologic symptoms. Subsequently, pulsed intravenous (IV) methylprednisolone (for suspected demyelination and spinal cord edema), IV immunoglobulin (IVIG) (for a possible parainfectious autoimmune process), and IV penicillin (for empiric syphilis treatment in case of a latent infection) were added to the patient's regimen, with partial improvement in numbness and weakness over several days. After 2 weeks, the patient's improvement plateaued with continued left leg weakness. Given concern for possible continued spinal cord inflammation, plasma exchange (PLEX) was initiated, and the patient's leg weakness improved. His skin lesions resolved over 3 weeks. He was discharged to outpatient rehabilitation therapy and was ambulatory with an assistive walking device at 1 month follow-up. He was also referred to outpatient neurosurgery for his presumed chronic cervical spinal canal stenosis.

Patient B

The second case of MPXV-associated encephalomyelitis occurred in a previously healthy, presumedly immunocompetent gay man in his 30s in DC (patient B). He had no known MPXV exposure or recent travel. He had not been vaccinated against monkeypox and his smallpox vaccination status was uncertain. In July 2022, he acutely developed fever and myalgia, which was followed by eruption of a diffuse vesiculopustular rash involving his face, extremities, trunk, and perianal area. Swabs of a lesion yielded positive *Orthopoxvirus* DNA PCR test results, later confirmed to be MPXV DNA. Five days after symptom onset, he developed bowel and bladder incontinence and progressive flaccid weakness of both lower extremities and was hospitalized. His condition progressed to altered mental status and obtundation during the next 2 days. He was intubated for airway protection and transferred to the intensive care unit. MRI of the brain showed nonenhancing lesions of the pons, cerebellum, and medulla without restricted diffusion (Figure 2). MRI of the spine showed multifocal, partially enhancing lesions in the central cervical and upper thoracic regions (Figure 2). Computed tomography imaging of the abdomen and pelvis demonstrated rectal thickening with pelvic lymphadenopathy consistent with proctitis, thought to be related to MPXV infection. CSF analysis demonstrated 30 white blood cells/μL with 89% lymphocytes and 11% monocytes; 4 red blood cells/μL, glucose 65 mg/dL, and protein 60 mg/dL. CSF bacterial cultures and CSF HSV and VZV PCR results were negative. Three CSF-specific oligoclonal bands were present. Serum and CSF aquaporin-4 and MOG antibody test results were negative. Serum HIV serologic and PCR test results were negative, as were serum RPR and CSF VDRL test results and rectal and urine gonorrhea and chlamydia screening results. SARS-CoV-2 reverse transcription–PCR nasopharyngeal swab test result was negative at admission and when febrile. CSF MPXV PCR test result was negative.

The patient started treatment with oral tecovirimat via nasogastric tube 2 days after neurologic symptom onset but quickly transitioned to IV tecovirimat over concerns for potential absorption issues. Because of concern for spinal cord edema, pulsed IV methylprednisolone was given with no immediate clinical improvement in weakness, but mild improvement in cognition. A parainfectious autoimmune

FIGURE 2. Magnetic resonance imaging of the brain and cervical spine of patient B with monkeypox-associated encephalomyelitis showing abnormal T2/fluid attenuated inversion recovery signal in the pons and cerebellum (A), medulla (B), and gray matter of the cervical spinal cord (C) — District of Columbia, July–August 2022



Photos/Matthew J. Copeland.

process was considered, and IVIG was started. However, the patient subsequently developed high fevers, leading to discontinuation of IVIG after 2 days of treatment. A course of PLEX was initiated and the patient began to substantially improve. After five sessions of PLEX, he was extubated, was speaking and following commands, and had improvement in his lower extremity weakness. His proctitis resolved and his skin lesions healed by 5 weeks. He was given IV rituximab, a monoclonal antibody medication, for maintenance immunosuppressive therapy and was discharged to acute inpatient rehabilitation, ambulating with an assistive walking device.

Discussion

Patients A and B had confirmed systemic MPXV infections with encephalomyelitis appearing within 5 and 9 days, respectively, of illness onset. The underlying pathology behind this is unclear but might represent either MPXV invasion of the CNS or a parainfectious autoimmune process triggered by systemic MPXV infection. Both patients had some clinical and radiographic features of acute disseminated encephalomyelitis (ADEM), typically a monophasic parainfectious autoimmune demyelinating disease of the CNS that primarily affects children but can also occur in adults (*7*). In past centuries, ADEM-like syndromes have been described in patients with presumed *Variola virus* infections (i.e., smallpox) (*8*,*9*).

In this report, neither patient was found to have MPXV nucleic acid in the CSF, which would have proven MPXV neuroinvasion. However, absence of detectable nucleic acid in the CSF is not uncommon among CNS viral infections. A CSF *Orthopoxvirus* immunoglobulin (Ig) M test for detection of virus-specific IgM antibodies, which could suggest viral neuroinvasion, was not performed because this test was not Clinical Laboratory Improvement Amendments (CLIA)–certified at the time of this report. Results of tests to look for the autoimmune CNS conditions NMOSD and MOGAD were negative. In patient A, neither the rash nor the neurologic condition was thought to be consistent with an active syphilis infection, and the cervical spinal canal stenosis did not fully explain his clinical condition.

Given that the pathologic mechanism for encephalomyelitis in these two instances is unknown, the best diagnostic

Summary

What is already known about this topic?

Monkeypox virus (MPXV) typically causes a febrile illness with lymphadenopathy and a diffuse vesiculopustular rash; neurologic complications are rare. The current monkeypox outbreak differs clinically and epidemiologically from previous outbreaks, and little is known about potential associated neurologic complications.

What is added by this report?

Two U.S. cases of encephalomyelitis associated with acute MPXV infection were identified during summer 2022. Whether the underlying pathophysiology resulted from direct viral neuroinvasion or a parainfectious autoimmune process is currently unknown.

What are the implications for public health practice?

Suspected cases of neurologic complications of monkeypox should be reported to state, tribal, local, or territorial health departments to improve understanding of the range of clinical manifestations of MPXV infections during the current outbreak and treatment options.

workup and treatment course for similar cases is unclear. For severe MPXV disease, tecovirimat is recommended as first-line antiviral therapy, although the degree of CNS penetration is unknown (*10*). For significant edema, demyelination, or an ADEM-like presentation, corticosteroids can be considered, although benefits should be weighed against the immunosuppressive risks during an active infection. In addition, for a suspected parainfectious autoimmune CNS process or ADEM-like presentation, empiric IVIG or PLEX (or PLEX followed by IVIG) can be considered (*7*). The role for anti-B–cell therapies such as rituximab is not known.

Clinicians and public health professionals should be aware of the range of possible clinical presentations of MPXV infections and potential treatments. Suspected cases should be reported to state, tribal, local, or territorial health departments to improve understanding of the range of clinical manifestations of MPXV infections and treatment options. Persons who have been exposed to monkeypox or are at higher risk of being exposed may be vaccinated against monkeypox to reduce the chance of disease and can consider other protective measures to reduce their risk for exposure to MPXV.**

** https://www.cdc.gov/poxvirus/monkeypox/prevention/index.html (Accessed September 7, 2022).

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Health Care Personnel Exposures to Subsequently Laboratory-Confirmed Monkeypox Patients — Colorado, 2022

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The risk for monkeypox transmission to health care personnel (HCP) caring for symptomatic patients is thought to be low but has not been thoroughly assessed in the context of the current global outbreak (*1*). Monkeypox typically spreads through close physical (often skin-to-skin) contact with lesions or scabs, body fluids, or respiratory secretions of a person with an active monkeypox infection. CDC currently recommends that HCP wear a gown, gloves, eye protection, and an N95 (or higher-level) respirator while caring for patients with suspected or confirmed monkeypox to protect themselves from infection[†] (*1*,*2*). The Colorado Department of Public Health and Environment (CDPHE) evaluated HCP exposures and personal protective equipment (PPE) use in health care settings during care of patients who subsequently received a diagnosis of *Orthopoxvirus* infection (presumptive monkeypox determined by a polymerase chain reaction [PCR] DNA assay) or monkeypox (real-time PCR assay and genetic sequencing performed by CDC). During May 1–July 31, 2022, a total of 313 HCP interacted with patients with subsequently diagnosed monkeypox infections while wearing various combinations of PPE; 23% wore all recommended PPE during their exposures. Twenty-eight percent of exposed HCP were considered to have had high- or intermediate-risk exposures and were therefore eligible to receive postexposure prophylaxis (PEP) with the JYNNEOS vaccine[§]; among those, 48% (12% of all exposed HCP) received the vaccine. PPE use varied by facility type: HCP in sexually transmitted infection (STI) clinics and community health centers reported the highest adherence to recommended PPE use, and primary and urgent care settings reported the lowest adherence. No HCP developed a monkeypox infection during the 21 days after exposure. These results suggest that the risk for transmission of monkeypox in health care settings is low. Infection prevention training is important in all health care settings, and these findings can guide future updates to PPE recommendations and risk classification in health care settings.

CDPHE collected data on clinical and nonclinical HCP exposed by treating, being within 6 feet of, or handling linens from a patient who subsequently received a diagnosis of monkeypox in health care settings during May 1–July 31, 2022. CDPHE interviewed patients with monkeypox and reviewed medical records to ascertain whether lesions were present during health care exposures. HCP who had cared for out-of-state patients or for patients who were lost to follow-up were excluded from the analysis. Exposure details, including types of PPE worn, types of interaction, and amount of time spent with the patient were collected for each HCP, and risk levels were assigned using the CDC HCP risk assessment criteria at the time (low or uncertain, intermediate, or high). HCP with high- or intermediate-risk exposures were offered JYNNEOS PEP vaccination and were actively monitored for symptoms for 21 days after the exposure.[¶] HCP with low-risk exposures were asked to self-monitor for symptoms for 21 days.[**] HCP who experienced symptoms were asked to notify CDPHE immediately, were excluded from work until symptoms resolved, and received *Orthopoxvirus* testing if rash or lesions occurred. All HCP included in the analysis completed the 21-day monitoring period. In addition, facilities reported all exposure, PPE, and exposure risk data to CDPHE. PEP administration data were obtained from reporting facilities and through the Colorado Immunization Information System. These data were summarized and stratified by facility type and job title. Analyses were completed using R statistical software (version 2021.09.2; The R Foundation). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[††]

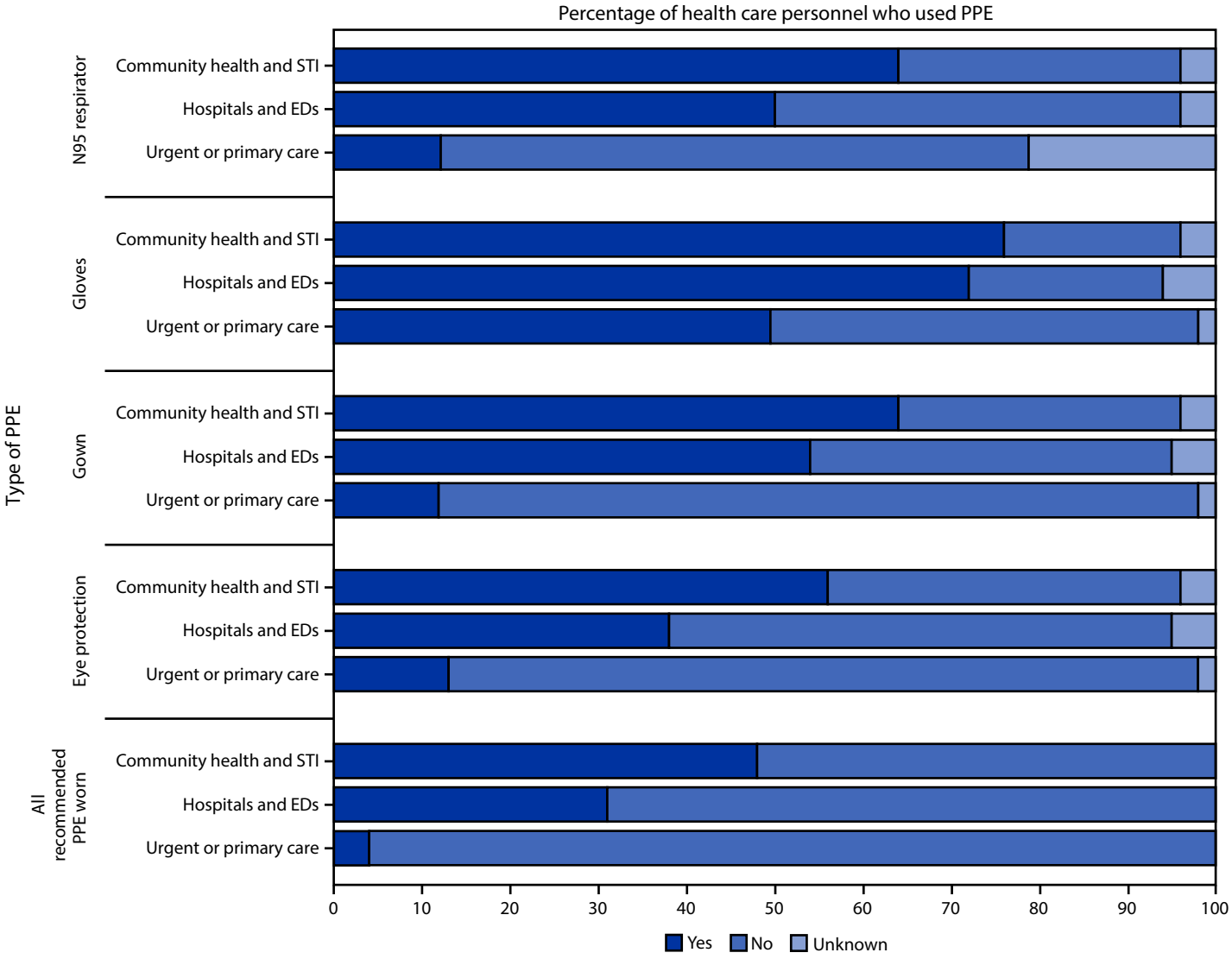
During May 1–July 31, 2022, a total of 313 HCP were exposed to 55 patients with monkeypox, including 20 high-risk, 67 intermediate-risk, and 226 low- or uncertain-risk exposures (Table). Seven HCP had exposure during aerosol-generating procedures; three of whom wore an N95 respirator during their exposure. Overall, 273 (87%) exposures to

[*] These authors contributed equally to this report.
[†] https://www.cdc.gov/poxvirus/monkeypox/clinicians/infection-control-healthcare.html
[§] https://www.fda.gov/vaccines-blood-biologics/jynneos
[¶] http://web.archive.org/web/20220615195256/https:/www.cdc.gov/poxvirus/monkeypox/clinicians/monitoring.html
[**] All exposed HCP received the recommended 21 days of monitoring after exposure, including those excluded from the analysis.
[††] 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

patients with monkeypox rash or lesions occurred, and 161 (59%) included direct contact with the patient's skin or lesions (gloves were worn in 125 exposures, were not worn in 30 exposures, and use of gloves was unknown for six exposures). Twenty-six (8%) exposed HCP reported handling linens; 23 (88%) of whom were wearing gloves. Approximately two thirds of encounters with monkeypox patients (215; 69%) lasted 5–30 minutes. Only one health care worker was exposed for >3 hours; this health care worker wore an N95 respirator and all other recommended PPE for the duration of the exposure.

Among the 313 exposed HCP, 118 (38%) reported wearing an N95 respirator while treating or interacting with monkeypox patients. N95 respirator use by HCP varied among health care settings: 64% of exposures of HCP in community health and STI clinics, 50% in hospitals and emergency departments (EDs), and 12% in primary and urgent care settings occurred while the health care worker was wearing an N95 respirator (Figure). Among the 72 (23%) HCP who wore all recommended PPE while treating monkeypox patients, all were classified as low or uncertain risk. Adherence to all recommended PPE ranged from 4% in primary and urgent care settings to 48% in community health and STI clinics. Clinical staff members reported higher PPE use than did nonclinical staff members, with providers and nurses reporting the highest compliance with recommendations (Supplementary Table, https://stacks.cdc.gov/view/cdc/121197).

FIGURE. Personal protective equipment use by health care personnel* exposed to patients with monkeypox, by facility type — Colorado, May 1–July 31, 2022



Abbreviations: ED = emergency department; PPE = personal protective equipment; STI = sexually transmitted infection.
* Number of health care personnel by facility type: community health and STI (25), hospitals and EDs (175), and urgent or primary care (113).

HCP with intermediate- and high-risk exposures (87; 28%) were eligible to receive PEP with JYNNEOS vaccine (Table). Among eligible HCP, 37 (43%) received PEP, including 10 (50%) with high-risk exposures and 27 (40%) with intermediate-risk exposures. Seven of the 313 exposed HCP experienced symptoms during their 21-day monitoring period; three had rash or lesions, and four had other nonspecific symptoms. Two of the three HCP with rash or lesions were tested for *Orthopoxvirus*; both PCR test results were negative, and the third health care worker had an alternative diagnosis for their rash (medication reaction).

Discussion

In the United States, data suggest that widespread community transmission of monkeypox has occurred in the context of sexual or close intimate contact (*3*). In Colorado, monkeypox transmission did not occur to 313 HCP with varying levels of exposure to patients with monkeypox during patient care or through contaminated materials. These findings are consistent with literature review from previous U.S. outbreaks (*1*) and internationally imported cases (*4*,*5*), with one case report of transmission to a health care worker after contact with contaminated patient linens in the United Kingdom during a previous outbreak (*6*), and one case of transmission to a health care worker in the United States during the current outbreak (*7*). Most HCP exposures in this analysis (72%) were classified as low or uncertain risk; only seven HCP (2%) were exposed during an aerosol-generating procedure. These data are consistent with evidence that occupationally acquired monkeypox is unlikely to occur when adhering to recommended infection prevention and control precautions.

Only 23% of exposed HCP wore all recommended PPE. Although mask use was common, likely because of current COVID-19 source control recommendations, only 38% of HCP wore N95 respirators, and 64%, 40%, and 31% wore gloves, gowns, and eye protection, respectively. These low percentages might have been due to lack of awareness of 1) a patient's symptoms before entering their care area, 2) community transmission, 3) monkeypox PPE recommendations, or 4) monkeypox signs and symptoms or atypical presentation (*3*).

These data suggest that opportunities exist to improve awareness and training among frontline HCP who are most likely to see patients with monkeypox, so that they can take steps to protect themselves from exposure. The need for increased awareness and preparation was most apparent in primary care and urgent care settings where adherence to recommended

TABLE. Health care personnel exposures to monkeypox patients, by facility type — Colorado, May 1–July 31, 2022

Exposure	No. (subsection %)			
	Total	Community health and STI	Hospitals and EDs	Urgent or primary care
Total	**313 (100)**	**25 (100)**	**175 (100)**	**113 (100)**
Risk classification*				
High†	**20 (6)**	2 (8)	8 (5)	10 (9)
Intermediate	**67 (21)**	4 (16)	33 (19)	30 (27)
Low or uncertain	**226 (72)**	19 (76)	134 (77)	73 (65)
Aerosol-generating procedure§ performed	**7 (2)**	0 (—)	7 (4)	0 (—)
N95 respirator use during aerosol-generating procedure	**3 (43)**	NA	3 (43)	NA
Lesions present during patient encounter	**273 (87)**	25 (100)	159 (91)	89 (79)
Touched patient when lesions were present	**161 (59)**	12 (48)	102 (64)	47 (53)
Glove use	**125 (78)**	9 (75)	85 (83)	31 (66)
No glove use	**30 (19)**	3 (25)	12 (12)	15 (32)
Unknown glove use	**6 (4)**	0 (—)	5 (5)	1 (2)
Handled linens	**26 (8)**	0 (—)	23 (13)	3 (3)
Glove use	**23 (88)**	NA	22 (96)	1 (33)
No glove use	**3 (12)**	NA	1 (4)	2 (67)
Unknown glove use	**0 (—)**	NA	0 (—)	0 (—)
Duration of exposure				
<5 mins	**22 (7)**	1 (4)	12 (7)	9 (8)
5–30 mins	**215 (69)**	14 (56)	106 (61)	95 (84)
>30 mins–3 hrs	**53 (17)**	6 (24)	42 (24)	5 (4)
>3 hrs¶	**1 (0)**	0 (—)	1 (1)	0 (—)

Abbreviations: ED = emergency department; NA = not applicable; STI = sexually transmitted infection.

* Risk classification determined by CDC Health Care Worker Exposure Criteria. http://web.archive.org/web/20220615195256/https:/www.cdc.gov/poxvirus/monkeypox/clinicians/monitoring.html

† One needlestick injury occurred in a community health and STI facility during phlebotomy and was considered a "high-risk" exposure; this health care worker received postexposure prophylaxis vaccination and did not develop monkeypox.

§ Aerosol-generating procedures included intubation and endoscopy.

¶ The health care worker with >3 hours of exposure wore an N95 respirator during their entire period of potential exposure.

Summary

What is already known about this topic?

Although risk for monkeypox transmission to health care personnel (HCP) is thought to be low, CDC recommends that HCP wear personal protective equipment (PPE) consisting of gown, gloves, eye protection, and an N95 (or higher-level) respirator while caring for patients with suspected or confirmed monkeypox.

What is added by this report?

Among 313 Colorado HCP exposed to patients with monkeypox, recommended PPE use and receipt of postexposure prophylaxis vaccination was low. HCP were assessed for risk and actively monitored for 21 days when indicated; none acquired monkeypox.

What are the implications for public health practice?

The risk for acquiring monkeypox among U.S. HCP after exposure to patients with monkeypox is very low. HCP in all health care settings can benefit from public health outreach regarding infection prevention education and training.

PPE use was lowest. STI clinics became referral centers in Colorado, which might explain the higher PPE adherence in these settings. PPE use varied by job type as well, with more clinical providers and nursing staff members typically wearing recommended PPE than nonclinical staff members.

The findings in this report are subject to at least four limitations. First, higher compliance in community health and STI clinics might not be generalizable nationwide because these sites were used as referral centers in Colorado; these clinics were often informed of patients with suspected monkeypox before the patient arrived and were aware of current PPE and infection control recommendations. Second, PEP vaccination data were limited and might have been underreported. The Colorado Immunization Information System verification process was limited because of potential typographical errors in HCP names or dates of birth, as well as whether a health care worker consented to their information being entered into the system. Third, data on exposures to contaminated materials were incomplete, limiting the ability to draw conclusions regarding this potential route of transmission. Finally, information about whether patients had covered lesions or worn facemasks during their health care visits was unavailable.

This study illustrated that the risk for HCP acquiring monkeypox after exposure to patients with monkeypox was very low despite incomplete adherence to recommended PPE, especially among primary and urgent care settings, and receipt of PEP by fewer than one half of eligible exposed HCP. Despite these gaps, no HCP in Colorado developed monkeypox during their 21-day monitoring period. These results underscore the importance of public health outreach to better understand the circumstances of HCP exposures so that prevention, infection prevention education, and training of HCP can be improved, especially in primary care and urgent care settings. In addition, these data might support future updates to PPE use recommendations and exposure risk classification in health care settings.

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Monkeypox in a Young Infant — Florida, 2022

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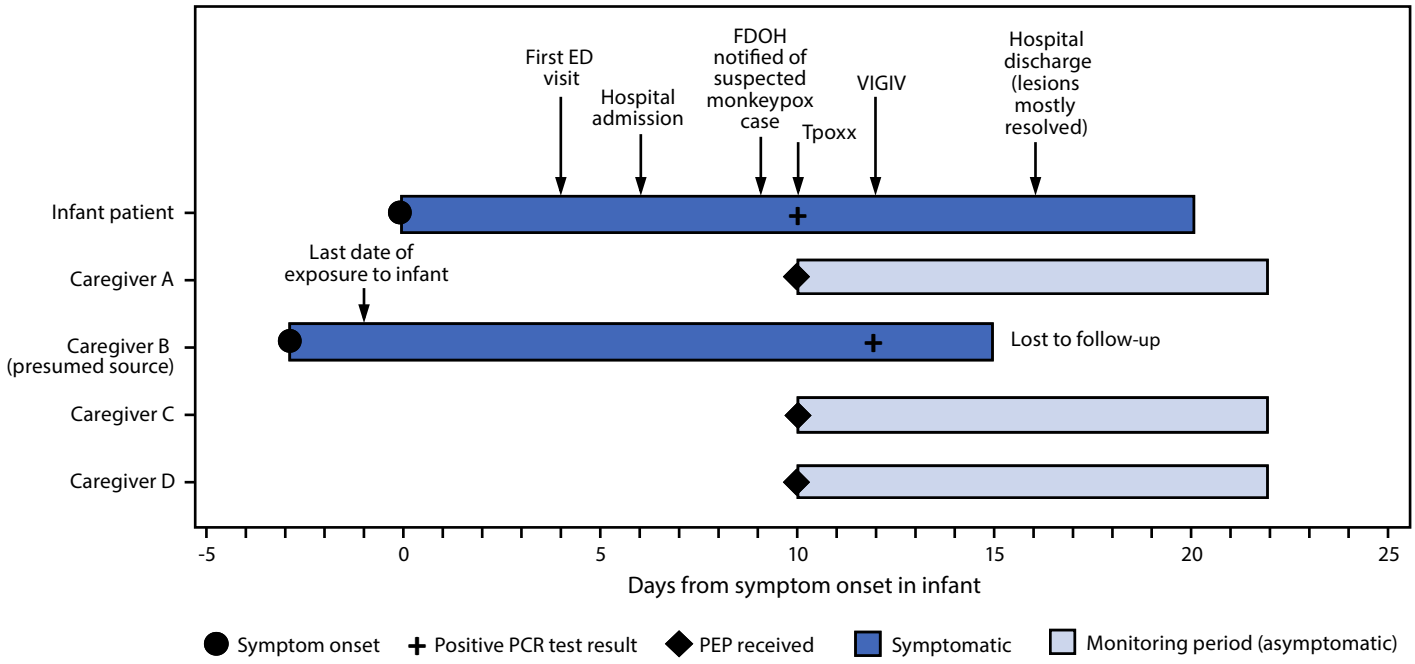
In August 2022, the Florida Department of Health (FDOH) was notified of a suspected case of monkeypox in an infant aged <2 months who was admitted to a Florida hospital with a rash and cellulitis. This case report highlights findings from the related epidemiologic investigation and describes the public health actions taken. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.* This is the youngest patient with confirmed monkeypox infection in Florida to date.

The infant was initially evaluated in an emergency department (ED) for a raised erythematous rash on the arms, legs, and trunk which had been present for 5 days. A rash swab was collected for bacterial culture and yielded a negative test result. Varicella, herpes simplex virus, and HIV testing were also negative. The patient returned to the ED 2 days later, at which time the rash had progressed to include numerous, diffusely scattered papulovesicular lesions over the body, many with central umbilication. The infant was admitted to the hospital with a diagnosis of molluscum contagiosum and started on intravenous antibiotics for secondary bacterial cellulitis associated with having scratched a lesion on the arm. The lesions subsequently spread to the back, soles of feet, face, and eyelid and became pustular over the first few days of admission. Swabs from forehead and back lesions tested positive for *Orthopoxvirus* DNA and Clade II *Monkeypox virus* DNA by polymerase chain reaction 10 days after rash onset (Figure). Results were confirmed by the Florida public health laboratory and CDC.† FDOH and hospital clinicians consulted with CDC regarding treatment options. The infant was treated with oral tecovirimat

* 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

† Patient specimen tested positive for nonvariola *Orthopoxvirus* DNA by polymerase chain reaction at Florida Bureau of Public Health Laboratories and was confirmed positive for Clade II *Monkeypox virus* DNA at CDC.

FIGURE. Timeline of symptom onset, testing, treatment, and public health interventions in response to a case of monkeypox in an infant* — Florida, 2022



Abbreviations: ED = emergency department; FDOH = Florida Department of Health; PCR = polymerase chain reaction; PEP = postexposure prophylaxis; Tpoxx = tecovirimat; VIGIV = Vaccinia Immune Globulin Intravenous.
* Caregiver B and caregiver C shared a bed with infant.

and Vaccinia Immune Globulin Intravenous (*1*). Prophylactic trifluridine[§] drops were administered to prevent ophthalmic complications from the eyelid lesion. The infant remained afebrile and stable throughout the course of illness, tolerated the treatments well, and fully recovered.

The infant had no history of travel, no history of acute infections in the 3 weeks preceding rash onset, no known immunocompromising conditions, did not attend a child care facility, and had no caregivers outside the home. Within the home, the infant was cared for by four caregivers. Caregiver A acted as the main guardian throughout the infant's hospital stay and had prolonged exposure with skin-to-skin contact. Caregiver B reported activities that placed him at high risk for monkeypox exposure during the 2 months preceding the infant's illness (*2*). Caregiver B reported hematuria and fever, followed by a rash within the 3 weeks before the infant's symptom onset. One day before the infant became symptomatic, caregiver B moved to another state and sought medical care for his symptoms. He received a positive *Orthopoxvirus* DNA test result 2 days after the infant's positive test result, after which, he was lost to follow-up. The infant had daily close contact with caregiver B in the home for 6 weeks before rash onset. Possible routes of transmission included shared bed linens and skin-to-skin contact through holding and daily care activities. Investigation identified three other household family members with household exposures to both the infant and caregiver B. Caregiver B, caregiver C, and the infant shared a bed for the 6 weeks preceding the infant's symptom onset. All household members (caregivers A, B, C, and D) held the infant with close skin-to-skin contact. Caregivers A, C, and D received postexposure prophylaxis with JYNNEOS vaccine and remained asymptomatic at 22 days after the infant's symptom onset (*2*,*3*). Caregiver A had also received smallpox vaccination during childhood.

To date, 27 confirmed cases of monkeypox in pediatric patients aged 0–15 years have been reported in the United States during the 2022 outbreak (*4*). Clinical presentations in children with monkeypox have been similar to those in adults, although children might have a higher risk for severe disease (*5*). Timely laboratory identification and thorough epidemiologic investigation are critical for effective public health response to monkeypox infection. In this case, contact tracing and postexposure prophylaxis vaccination of close contacts of the affected infant might have prevented further transmission to household members (*3*). Clinicians should consider monkeypox infection as a differential diagnosis in pediatric patients with pustular or vesicular rashes and be aware of the possibility for household transmission to pediatric patients, particularly if the children meet epidemiologic exposure criteria for diagnosis of monkeypox (*6*).

[§] Prophylactic trifluridine is an antiviral drug for topical treatment of epithelial keratosis caused by herpes simplex virus.

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Notes from the Field

Norovirus Outbreaks Reported Through NoroSTAT — 12 States, August 2012–July 2022

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Norovirus is the leading cause of acute gastroenteritis in the United States (*1*). In April 2020, the incidence of norovirus outbreaks in the United States declined substantially, likely because of implementation of COVID-19–related nonpharmaceutical interventions, such as facility closures, social distancing, and increased hand hygiene (*2*). Similar declines were observed in other countries (*3*,*4*). Norovirus outbreaks in the United States increased rapidly starting in January 2022, approaching prepandemic (i.e., 2012–2019) levels. Norovirus transmission can be prevented by thorough handwashing and proper cleaning and disinfection of contaminated surfaces.

In 2012, CDC established the Norovirus Sentinel Testing and Tracking Network (NoroSTAT) to improve timeliness and completeness of surveillance for norovirus outbreaks that occur in the United States. NoroSTAT is a collaboration between CDC and 12 state health departments.* Outbreaks are defined as two or more cases of illness associated with a common exposure. NoroSTAT-participating states report a minimum set of data elements† to the National Outbreak Reporting System§ for all confirmed norovirus outbreaks (i.e., outbreaks with two or more laboratory-confirmed norovirus cases) and suspected norovirus outbreaks (i.e., outbreaks with fewer than two laboratory-confirmed norovirus cases) within 7 business days of notification. These states also upload typing information for norovirus-positive outbreak specimens to CaliciNet,¶ the national norovirus laboratory surveillance network, within 7 business days of receipt of two outbreak-associated norovirus-positive stool specimens at the respective state public health laboratory. Outbreak reports are organized into surveillance years (i.e., August 1–July 31) based on the state funding cycle.**

During the 2021–2022 surveillance year (August 1, 2021–July 31, 2022), the 12 NoroSTAT-participating states reported 992 norovirus outbreaks to CDC (Figure). In comparison, the same states reported 1,056 and 343 norovirus outbreaks during the 2019–2020 and 2020–2021 surveillance years, respectively. The number of norovirus outbreaks reported by these states during prepandemic surveillance years ranged from 1,219 (2015–2016) to 1,471 (2018–2019). Norovirus outbreak characteristics reported by NoroSTAT-participating states during 2021–2022 were similar to those reported during prepandemic years. Most outbreaks (82%) were due to person-to-person spread (prepandemic range = 71%–85%). The majority (59%) of outbreaks occurred in long-term care facilities (prepandemic range = 53%–68%); 17% were laboratory-confirmed (prepandemic range = 22%–48%). Among laboratory-confirmed outbreaks with typing information during 2021–2022, a total of 43% were GII.4 Sydney(P16), which has been the predominant norovirus strain since its emergence during 2015–2016 (*5*).

The number of norovirus outbreaks that NoroSTAT-participating states reported during the 2021–2022 surveillance year was nearly three times the number reported during the 2020–2021 surveillance year. Nonpharmaceutical interventions implemented during the COVID-19 pandemic were likely effective in preventing outbreaks of other infectious diseases, including norovirus. As the use of nonpharmaceutical interventions has relaxed, norovirus outbreak incidence has returned to levels similar to those during prepandemic surveillance years, and GII.4 viruses continue to cause the largest proportion of norovirus outbreaks. Norovirus transmission can be prevented by handwashing thoroughly with soap and water, avoiding food preparation until ≥48 hours after symptoms end, and proper cleaning and disinfection of surfaces contaminated by vomitus or diarrhea.††

* Massachusetts, Michigan, Minnesota, Nebraska, New Mexico, Ohio, Oregon, South Carolina, Tennessee, Virginia, Wisconsin, and Wyoming.

† Within 7 business days of health department notification, NoroSTAT-participating states are required to report the following data elements to CDC for all norovirus outbreaks: state report ID, primary mode of outbreak transmission, date of first illness onset (at the time of initial report), date of notification to state health department, state in which the outbreak exposure occurred, estimated total number of primary ill cases, confirmed or suspected etiology, and outbreak setting.

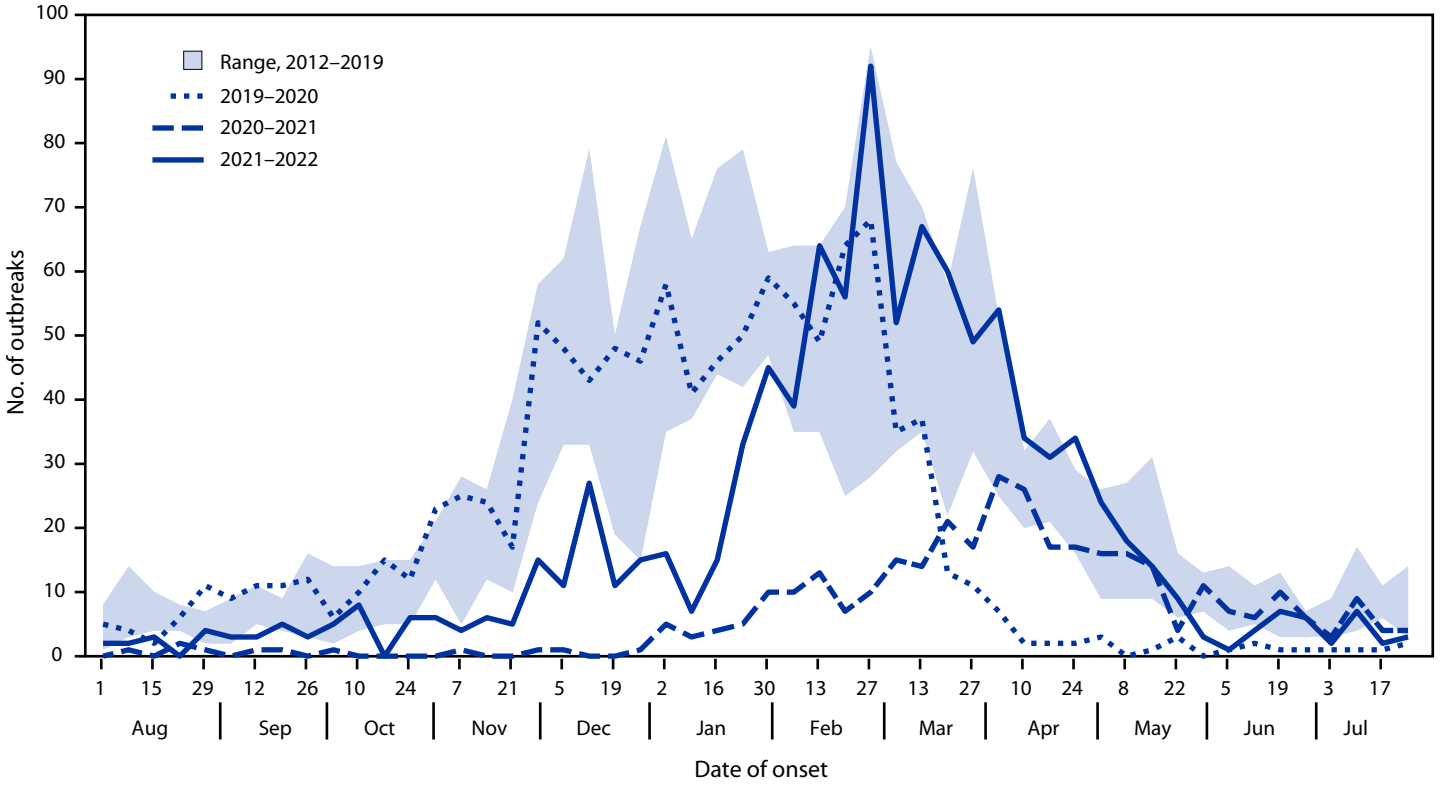
§ https://www.cdc.gov/nors/index.html

¶ https://www.cdc.gov/norovirus/reporting/calicinet/index.html

** https://www.cdc.gov/ncezid/dpei/epidemiology-laboratory-capacity.html

†† https://www.cdc.gov/norovirus/about/prevention.html

FIGURE. Number of norovirus outbreaks reported to the National Outbreak Reporting System by Norovirus Sentinel Testing and Tracking Network states, by month of outbreak onset — 12 states, 2012–2022*,†,§,¶



Abbreviation: NoroSTAT = Norovirus Sentinel Testing and Tracking Network.
* Michigan and South Carolina joined the NoroSTAT network at the start of the 2015–2016 surveillance year; 2012–2015 data from these states were added for comparison.
† Massachusetts and Virginia joined the NoroSTAT network at the start of the 2016–2017 surveillance year; 2012–2016 data from these states were added for comparison.
§ New Mexico and Wyoming joined the NoroSTAT network at the start of the 2018–2019 surveillance year; 2012–2018 data from these states were added for comparison.
¶ Nebraska joined the NoroSTAT network at the start of the 2019–2020 surveillance year; 2012–2019 data from this state were added for comparison.

NoroSTAT Network

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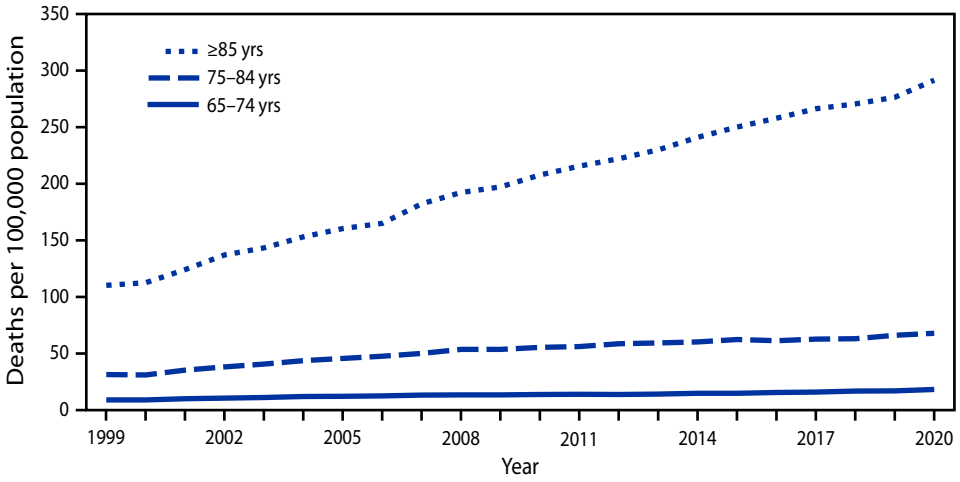
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Death Rates* from Unintentional Falls† Among Persons Aged ≥65 Years, by Age Group — National Vital Statistics System, United States, 1999–2020



* Deaths per 100,000 population.
† Deaths from unintentional falls are identified using the *International Classification of Diseases, Tenth Revision* underlying cause-of-death codes W00–W19.

During 1999–2020, death rates from unintentional falls among persons aged ≥65 years increased among all age groups. The largest increase occurred among persons aged ≥85 years, from 110.2 per 100,000 population in 1999 to 291.5 in 2020. Among persons aged 75–84 years, the rate increased from 31.5 to 67.9, and among those aged 65–74 years, the rate increased from 9.0 to 18.2. Throughout the period, rates were highest among persons aged ≥85 years, followed by rates among persons aged 75–84 years, and were lowest among persons aged 65–74 years.

Source: National Vital Statistics System, Mortality Data. https://www.cdc.gov/nchs/nvss/deaths.htm

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For more information on this topic, CDC recommends the following link: https://www.cdc.gov/falls

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