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Fleaborne Typhus–Associated Deaths — Los Angeles County, California, 2022

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Abstract

Fleaborne typhus (also known as murine typhus), a widely distributed vectorborne zoonosis caused by *Rickettsia typhi*, is a moderately severe, but infrequently fatal illness; among patients who receive doxycycline, the case-fatality rate is <1%. Fleaborne typhus is a mandated reportable condition in California. Reported fleaborne typhus cases in Los Angeles County have been increasing since 2010, with the highest number (171) reported during 2022. During June–October 2022, Los Angeles County Department of Public Health learned of three fleaborne typhus–associated deaths. This report describes the clinical presentation, illness course, and methods used to diagnose fleaborne typhus in these three cases. Severe fleaborne typhus manifestations among these cases included hemophagocytic lymphohistiocytosis, a rare immune hyperactivation syndrome that can occur in the infection setting; myocarditis; and septic shock with disseminated intravascular coagulation. Increased health care provider and public health awareness of the prevalence and severity of fleaborne typhus and of the importance of early doxycycline therapy is essential for prevention and treatment efforts.

Introduction

Fleaborne typhus is transmitted from infected fleas by inoculation of flea feces into the flea bite site, a skin abrasion, or mucous membranes (*1*). The Oriental rat flea (*Xenopsylla cheopis*), a parasite of rats, is the historical vector (*2*). The cat flea (*Ctenocephalides felis*), whose principal host is the domestic cat (but which is also found on opossums, dogs, and rats) is the predominant vector in suburban areas of the United States* (*3*). Signs and symptoms of fleaborne typhus include fever, headache, a palm- and sole-sparing rash, hepatitis, and thrombocytopenia (*4*). Approximately one third of infected patients require intensive care for associated aseptic meningitis, seizures, adult respiratory distress syndrome, or septic shock (*4*); however, among patients who receive doxycycline therapy, the case-fatality rate is <1% (*5*). Most current cases in the United States are identified in California, Hawaii, and Texas (*4*). During 1985–2015, among 3,048 fleaborne typhus cases in Texas, 11 (0.4%) were fatal (*6*). The disease is endemic in Los Angeles County (LAC), and reporting is mandated in California (Figure). Before 2022, the most recent fleaborne typhus–associated death in LAC was reported in 1993.

Methods

As part of fleaborne typhus surveillance in LAC, retrospective medical record review and case or next-of-kin interviews are conducted for all reported cases with presumptive or confirmatory laboratory evidence of infection. A presumptive fleaborne typhus case includes detection of *R. typhi* immunoglobulin (Ig) G antibodies at titers ≥1:128 or IgM titers ≥1:256 by indirect immunofluorescence antibody assay obtained from specimens

INSIDE

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

* http://www.publichealth.lacounty.gov/acd/vectortyphus.htm (Accessed January 25, 2023).

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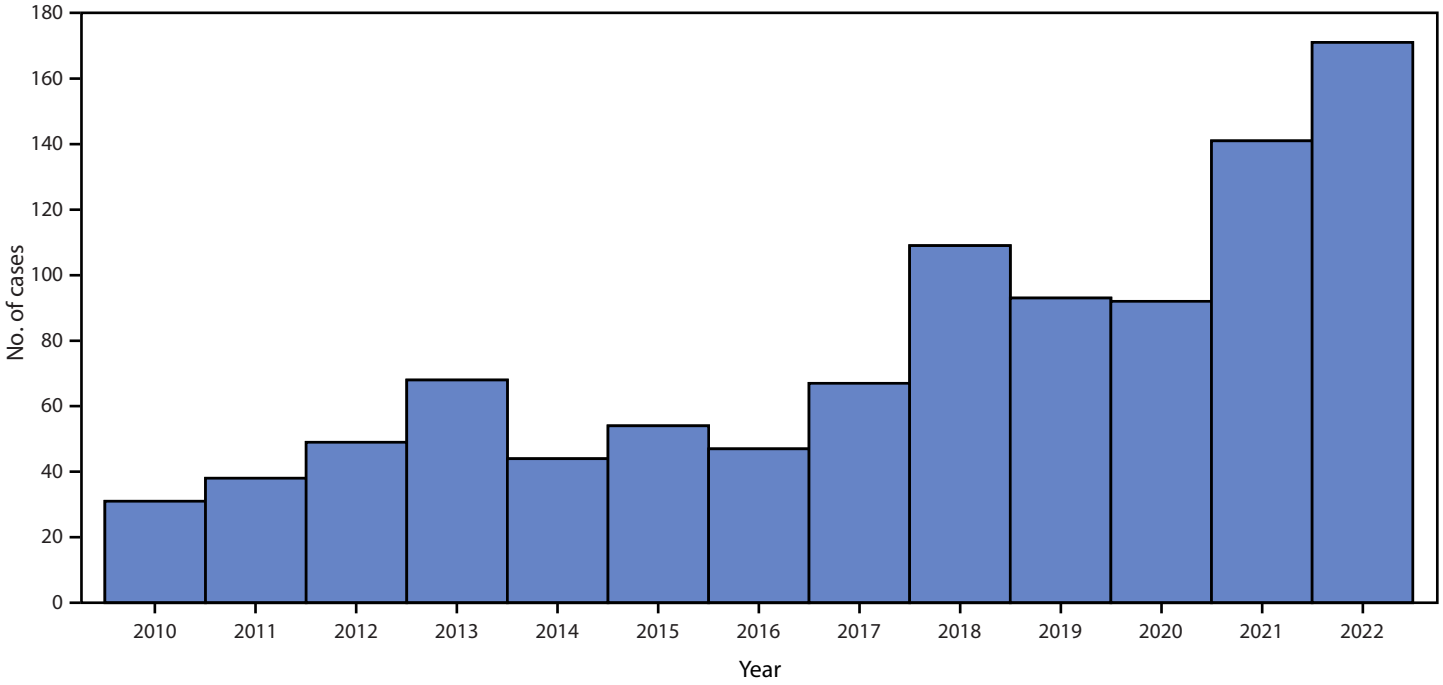
FIGURE. Fleaborne typhus cases, by year — Los Angeles County, California* 2010–2022



* Excluding the cities of Pasadena and Long Beach; data include confirmed, probable, and suspected cases.

collected within 60 days of illness onset.† Additional testing was performed at the California Department of Public Health Viral and Rickettsial Disease Laboratory for severe or fatal cases, and those in which clinical criteria were met but antibody titers were below case definition thresholds. Two types of real-time

† Fever as reported by the patient or health care provider and two or more of the following signs or symptoms: headache, myalgia, rash, nausea or vomiting, thrombocytopenia, or elevation of hepatic transaminases. http://publichealth.lacounty.gov/acd/Diseases/EpiForms/TyphusRep.pdf

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polymerase chain reaction (PCR) assays were used, one that identified a 119-base-pair (bp) repeat region within the gene for surface cell antigen 2 (an autotransporter protein), or at the Rickettsial Zoonoses Branch at CDC, an assay that amplified 146-bp or 197-bp fragments of intergenic regions of *R. typhi*.

For the reported deaths in 2022, autopsy findings were reviewed to confirm the cause of death. Testing for *R. typhi* antigens using an immunohistochemical stain was performed on tissues of one patient with fatal fleaborne typhus obtained at autopsy (*7*). This activity was reviewed by CDC and conducted consistent with applicable federal law and CDC policy.[§]

Results

Case Series

Patient A. In June 2022, a man identifying as Hispanic[¶] aged 68 years was evaluated in an emergency department (ED) for a 3-day history of fever and progressive lower extremity weakness (Table). Medical history included diffuse lymphadenopathy, obesity, hypertension, diabetes mellitus type 2, and peripheral vascular disease complicated by a chronic left foot ulcer. He had anemia and elevated liver enzymes and was admitted to the hospital with a diagnosis of sepsis and treated with broad-spectrum antibiotics. His mental status deteriorated, and he became difficult to rouse. On hospital day 8, he experienced hypotension and atrial fibrillation with rapid ventricular response and was transferred to the intensive care unit. The next day, he experienced hypoxemic respiratory failure and was placed on mechanical ventilation; the day after, he required vasopressor support and was given stress-dose steroids. On hospital day 9, a bone marrow biopsy was notable for scattered hemophagocytosis (histiocytic phagocytosis of red blood cells, white blood cells, platelets, and their precursors), and on hospital day 16, he received a diagnosis of hemophagocytic lymphohistiocytosis (HLH), a rare immune system disease, for which he received chemotherapy and infection prophylaxis as indicated by HLH-2004 protocol (*8*). He received doxycycline on hospital day 18, after receiving a positive Karius test[**] result for *R. typhi*. On hospital day 24, he no longer required mechanical ventilation, was extubated, and remained minimally responsive. On hospital day 29, he experienced multiorgan failure and transitioned to comfort care; he died on hospital day 30. Death was attributed to fleaborne typhus–induced HLH and septic shock. Potential exposure to rodents and fleas included proximity of the patient's home to a highway and litter.

Patient B. In August 2022, a woman identifying as Hispanic aged 49 years was evaluated at an urgent care facility for a 2-day history of headache and fever. Medical history included obesity, hypertension, hyperlipidemia, and diabetes mellitus type 2. During that visit she received a negative SARS-CoV-2 test result and was given a prescription for antihistamines and nasal steroids to treat presumed allergic rhinitis. Five days later, she visited an ED with fever, chills, night sweats, headache, and back pain. She received intravenous fluids and was discharged after symptomatic improvement. She returned to the ED the next day where she was found to be thrombocytopenic, hypokalemic, and had elevated liver enzymes; she was admitted to the hospital with a diagnosis of sepsis; treatment with broad-spectrum antibiotics was initiated. On hospital day 2, she experienced supraventricular tachycardia and two episodes of cardiac arrest with successful resuscitation. Cardiac catheterization found stress cardiomyopathy and no coronary artery disease. In light of the patient's headache, fever and elevated transaminases, an infectious diseases physician recommended treatment with doxycycline, which was started on hospital day 2, for possible fleaborne typhus. The patient subsequently experienced multiorgan failure and died on hospital day 3. Autopsy confirmed myocarditis as a proximate cause of death. Immunohistochemistry evaluation for typhus group *Rickettsia* demonstrated rare, multifocal staining of rickettsial antigens in endothelial cells in small blood vessels of the heart and less frequently in endothelial cells lining the sinusoidal spaces of the liver (Supplementary Figure, https://stacks.cdc.gov/view/cdc/131262). Potential flea exposure included stray kittens living in the patient's backyard.

Patient C. In October 2022, a man identifying as Hispanic aged 71 years who was experiencing homelessness and had a history of alcohol use disorder was brought to an ED by ambulance after having been observed lying in the same place on the ground for 24 hours. He was febrile, disoriented, hypotensive, tachypneic, and experiencing atrial fibrillation with rapid ventricular response. He had anemia, thrombocytopenia, and a low white blood cell count with a predominance of immature neutrophils, in addition to lactic acidosis and elevated liver enzymes. He had a petechial rash on his legs and torso. Treatment for suspected meningitis, fleaborne typhus, and neurosyphilis was initiated. On hospital day 2, the patient became hypoxemic, and on hospital day 4, experienced hypoxemic respiratory failure and was placed on mechanical ventilation. He experienced worsening multiorgan failure and disseminated intravascular coagulation and transitioned to comfort care; he died on hospital day 5. Causes of death listed

[§] 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.

[¶] Persons of Hispanic or Latino (Hispanic) origin might be of any race but are categorized as Hispanic.

[**] A noninvasive, rapid cell-free DNA-based diagnostic test capable of identifying bacteria, mycobacteria, DNA viruses, fungi, and protozoa in blood. Host and microbial cell-free DNA isolated from the patient's blood specimen is sequenced then analyzed using bioinformatics of DNA-based pathogen genomes. The test is useful for identifying rare pathogens. https://kariusdx.com/

TABLE. Demographic, epidemiologic, and clinical characteristics of persons who died from fleaborne (murine) typhus–related illness — Los Angeles County, California, June–October 2022

Characteristic	Patient A	Patient B	Patient C
Age, yrs (sex)	68 (male)	49 (female)	71 (male)
Ethnicity*	Hispanic	Hispanic	Hispanic
Signs and symptoms	Fever for 3 days and progressive lower extremity weakness	Headache, fever, chills, night sweats, and back pain for 7 days	Fever, disorientation, hypotension, AF with rapid ventricular response, and petechial rash (on legs and torso)
Potential exposure	Proximity of the patient's home to a highway and litter	Stray kittens in patient's backyard	Lived in an encampment inhabited by persons experiencing homelessness
Underlying medical conditions	Diffuse lymphadenopathy, obesity, hypertension, DM type 2, PVD, and chronic left foot ulcer	Obesity, hypertension, hyperlipidemia, and DM type 2	Alcohol and methamphetamine use
Abnormal laboratory values (referent range)			
White blood cell count (4.5–10.0/μl)	—†	—†	3.4
Immature neutrophils (<10%)	—†	—†	15
Platelet count (160–360/μl)	—†	130	31
Hemoglobin (13.5–16.5/μl)	10.4	—†	10.1
Sodium (135–145 mmol/L)	126	—†	—†
Potassium (3.5–5.1 mmol/L)	—†	2.8	—†
Magnesium (1.6–2.6 per md/dL)	—†	1.5	—†
Total bilirubin (<1 mg/dL)	—†	—†	1
Alanine aminotransferase (10–50 U/L)	143	114	73
Aspartate aminotransferase (10–50 U/L)	102	141	224
Venous lactate (0.5–1.6 mmol/L)	2.6	—†	4.8
C-reactive protein (<0.3 mg/L)	—†	269.2	—†
Treatments received	Cefepime, vancomycin, piperacillin-tazobactam, etoposide, dexamethasone, fluconazole, and trimethoprim-sulfamethoxazole	Ceftriaxone, vancomycin, and meropenem	Ceftriaxone, vancomycin, acyclovir, and penicillin
Doxycycline therapy started, hospital day	18	2	2
Major clinical events	Mental status deterioration, hypotension, AF with rapid ventricular response, hypoxic respiratory failure, HLH, and severe septic shock	SVT, two episodes of cardiac arrest, and multiorgan failure	Hypoxemic respiratory failure, multiorgan failure, and DIC
Microbiology results	Epstein-Barr virus infection diagnosed by PCR (hospital days 9 and 16), HSV 1 diagnosed by bronchoscopy specimen, (hospital day 16), multidrug resistant *Escherichia coli* detected in blood cultures, and CMV diagnosed by PCR (hospital day 29)	Parvovirus B19 DNA was detected in blood and heart tissue by PCR	—†
***Rickettsia typhi* molecular testing results**			
Titer collection timing, hospital day	19	2	2
Titer result timing, hospital day	28	Patient deceased	Patient deceased
Titer result			
IgM titer	>1:256	1:128	1:128
IgG titer	>1:256	1:64	>1:256
VRDL result			
IgG titer	Not submitted	>1:1,024	Not submitted
PCR result	Not submitted	Positive	Positive
Karius test§			
Timing, hospital day	18	Not submitted	Not submitted
Result	Positive for *R. typhi*	—†	—†
Days to death after hospitalization	30	3	5
Cause of death¶	Fleaborne typhus–induced HLH and septic shock	Myocarditis	Septic shock associated with shock liver, hyperkalemia, and lactic acidosis

Abbreviations: AF = atrial fibrillation; CMV = cytomegalovirus; DIC = disseminated intravascular coagulation; DM = diabetes mellitus; HLH = hemophagocytic lymphohistiocytosis; HSV = herpes simplex virus; Ig = immunoglobulin; PCR = real-time polymerase chain reaction; PVD = peripheral vascular disease; SVT = supraventricular tachycardia; VRDL = Viral and Rickettsial Disease Laboratory.

* Persons of Hispanic or Latino (Hispanic) origin might be of any race but are categorized as Hispanic.

† Result within normal limits.

§ A noninvasive, rapid cell-free DNA-based diagnostic test capable of identifying bacteria, mycobacteria, DNA viruses, fungi, and protozoa in blood. Host and microbial cell-free DNA isolated from the patient's blood specimen is sequenced then analyzed using bioinformatics of DNA-based pathogen genomes. The test is useful for identifying rare pathogens. https://kariusdx.com/

¶ As recorded on the death certificate.

Summary

What is already known about this topic?

Fleaborne typhus, a vectorborne zoonosis caused by *Rickettsia typhi*, is a moderately severe but rarely fatal illness.

What is added by this report?

Fleaborne typhus cases in Los Angeles County (LAC), California increased from 31 in 2010 to 171 in 2022. In 2022, three associated deaths occurred among LAC adults with underlying medical conditions; severe manifestations included hemophagocytic lymphohistiocytosis, myocarditis, and septic shock.

What are the implications for public health practice?

Health care providers should suspect fleaborne typhus in patients with compatible symptoms who live in or travel to areas with endemic disease or are exposed to reservoir animals; prompt initiation of doxycycline therapy is critical. Monitoring rodent, opossum, free-roaming cat, and dog flea infestations and the numbers of infected fleas is needed to understand disease ecology and more efficiently direct interventions to prevent disease in humans.

on the death certificate were septic shock associated with shock liver, hyperkalemia, and lactic acidosis. The patient might have also been exposed to fleas and rodents at the encampment where he lived.

Discussion

The identification of three fatal cases of fleaborne typhus in LAC in 2022 occurred in the context of a marked increase in LAC cases in recent years. Texas is also experiencing a substantial increase in the prevalence and geographic distribution of fleaborne typhus (*4*). Although reports of HLH among patients with *R. typhi* infection are rare (*9*), these three fleaborne typhus-associated deaths highlight the range of potentially severe manifestations of this infection, including HLH, myocarditis, and septic shock with disseminated intravascular coagulation. A recent study noted a case-fatality rate of <1% (*6*); in LAC, the case-fatality rate was noted to be 1.8% in 2022. It is likely that given the overall increase in cases, more persons with severe disease and deaths were identified. In addition, all three patients had comorbidities that might have placed them at increased risk for severe disease. A change in the pathogenicity of *R. typhi*, although possible, has not been documented and needs to be monitored.

One possible reason for the observed substantial increase in fleaborne typhus cases in suburban areas is the prevalence of the cat flea (*Ctenocephalides felis*), an abundant nonselective parasite vector that affects free-roaming as well as companion animals (*4*). Another possible reason could be an increase in rodent reservoirs in urban and suburban areas in LAC. The fact that fleaborne typhus is no longer a nationally notifiable disease poses surveillance challenges across the United States.[††] *R. typhi*–induced myocarditis has been reported in areas with endemic transmission (*10*) and should be considered when evaluating a patient with acute coronary syndrome (a condition resulting from a sudden reduction of blood flow to the heart) and an unexplained febrile illness from such an area.

All three fatal cases described in this report had positive *R. typhi* molecular testing results, which confirmed recent fleaborne typhus infection. Commercial *R. typhi* PCR testing is unavailable, and confirmation of fleaborne typhus relies upon evidence of a fourfold increase in IgG antibody titers from acute to postconvalescent illness phases.

Limitations

The findings in this report are subject to at least two limitations. First, it is likely that only patients with severe disease are tested for *R. typhi*, and surveillance is currently missing patients with milder disease who might not have access to or seek medical care or receive testing for *R. typhi* from their health care provider. Second, patients with *R. typhi* infections were not followed after they were discharged from the hospital, leading to the possibility that some deaths due to *R. typhi* might have been missed.

Implications for Public Health Practice

No vaccine to prevent fleaborne typhus currently exists. Use of veterinarian-approved flea control products on pets can reduce the risk for flea exposures to humans. Because *R. typhi* testing during early illness might result in nondetectable or low antibody titers, and waiting for convalescent titers inherently delays confirmation of diagnosis, health care providers should initiate treatment with doxycycline as soon as fleaborne typhus is suspected. In addition, health care providers should consider fleaborne typhus in any patient with fever, headache, and rash, particularly if the patient lives in or recently traveled to an area with endemic disease or had exposure to a reservoir animal (e.g., rodents, opossums, or feral cats).[§§] Monitoring rodent, opossum, cat, and dog flea infestations and the numbers of infected fleas is important to better understand disease ecology and more effectively direct interventions to prevent human disease.

[††] https://www.cdc.gov/typhus/murine/index.html.
[§§] https://wwwnc.cdc.gov/travel/yellowbook/2024/infections-diseases/rickettsial-diseases#:~:text

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References

1. Azad AF. Epidemiology of murine typhus. Annu Rev Entomol 1990;35:553–69. PMID:2105686 https://doi.org/10.1146/annurev.en.35.010190.003005
2. Traub R, Wisseman CL. The ecology of murine typhus–a critical review. Trop Dis Bull 1978;75:237–317. PMID:705902
3. Adams WH, Emmons RW, Brooks JE. The changing ecology of murine (endemic) typhus in Southern California. Am J Trop Med Hyg 1970;19:311–8. PMID:4986201 https://doi.org/10.4269/ajtmh.1970.19.311
4. Anstead GM. History, rats, fleas, and opossums. II. The decline and resurgence of flea-borne typhus in the United States, 1945–2019. Trop Med Infect Dis 2020;6:2. PMID:33379251 https://doi.org/10.3390/tropicalmed6010002
5. Civen R, Ngo V. Murine typhus: an unrecognized suburban vectorborne disease. Clin Infect Dis 2008;46:913–8. PMID:18260783 https://doi.org/10.1086/527443
6. Pieracci EG, Evert N, Drexler NA, et al. Fatal flea-borne typhus in Texas: a retrospective case series, 1985–2015. Am J Trop Med Hyg 2017;96:1088–93. PMID:28500797 https://doi.org/10.4269/ajtmh.16-0465
7. Zanetti G, Francioli P, Tagan D, Paddock CD, Zaki SR. Imported epidemic typhus. Lancet 1998;352:1709. PMID:9853468 https://doi.org/10.1016/S0140-6736(05)61487-0
8. Henter J-I, Horne A, Aricó M, et al. HLH-2004: diagnostic and therapeutic guidelines for hemophagocytic lymphohistiocytosis. Pediatr Blood Cancer 2007;48:124–31. PMID:16937360 https://doi.org/10.1002/pbc.21039
9. Leal-López VF, Arias-León JJ, Faccini-Martínez AA, et al. Fatal murine typhus with hemophagocytic lymphohistiocytosis in a child. Rev Inst Med Trop São Paulo 2020;62:e99. PMID:33331518 https://doi.org/10.1590/s1678-9946202062099
10. Madan R, Muthujumar V, Premji S, Khan R, Schmidt RM. Murine typhus-induced myocarditis. Am J Med 2022;135:e397–8. PMID:35576998 https://doi.org/10.1016/j.amjmed.2022.04.018

Cluster of Carbapenemase-Producing Carbapenem-Resistant *Pseudomonas aeruginosa* Among Patients in an Adult Intensive Care Unit — Idaho, 2021–2022

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Abstract

Treatment of carbapenemase-producing carbapenem-resistant *Pseudomonas aeruginosa* (CP-CRPA) infections is challenging because of antibiotic resistance. CP-CRPA infections are highly transmissible in health care settings because they can spread from person to person and from environmental sources such as sink drains and toilets. During September 2021–January 2022, an Idaho hospital (hospital A) isolated CP-CRPA from sputum of two patients who stayed in the same intensive care unit (ICU) room (room X), 4 months apart. Both isolates had active-on-imipenem metallo-beta-lactamase (IMP) carbapenemase gene type 84 ($bla_{\text{IMP-84}}$) and were characterized as multilocus sequence type 235 (ST235). A health care–associated infections team from the Idaho Division of Public Health visited hospital A during March 21–22, 2022, to discuss the cluster investigation with hospital A staff members and to collect environmental samples. CP-CRPA ST235 with $bla_{\text{IMP-84}}$ was isolated from swab samples of one sink in room X, suggesting it was the likely environmental source of transmission. Recommended prevention and control measures included application of drain biofilm disinfectant, screening of future patients who stay in room X (e.g., the next 10 occupants) upon reopening, and continuing submission of carbapenem-resistant *P. aeruginosa* (CRPA) isolates to public health laboratories. Repeat environmental sampling did not detect any CRPA. As of December 2022, no additional CP-CRPA isolates had been reported by hospital A. Collaboration between health care facilities and public health agencies, including testing of CRPA isolates for carbapenemase genes and implementation of sink hygiene interventions, was critical in the identification of and response to this CP-CRPA cluster in a health care setting.

Investigation and Results

A collaborative investigation involving the Idaho Division of Public Health (IDPH) Healthcare Associated Infections (HAI) program, Idaho Bureau of Laboratories (IBL), the Utah Public Health Laboratory (UPHL), and CDC was undertaken to identify the etiology of the infection. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.*

On September 17, 2021, an Idaho hospital (hospital A) collected sputum by endotracheal tube aspiration of a woman aged 50–65 years (patient 1), who received mechanical ventilation during 3 of 5 weeks of hospitalization in an intensive care unit (ICU) room (room X). Carbapenemase-producing carbapenem-resistant *Pseudomonas aeruginosa* (CP-CRPA) was detected only in this fifth serial sputum specimen, suggesting hospital-acquired infection.

Carbapenem-resistant *P. aeruginosa* (CRPA) isolates in Idaho are voluntarily submitted to IBL for detection of carbapenemase genes.† IBL detected phenotypic carbapenemase production using the modified carbapenem inactivation method, but did not detect any of the four most common carbapenemase genes§ using real-time polymerase chain reaction (PCR), which suggested that a different carbapenemase gene was present. Whole genome sequencing by UPHL, a regional laboratory in CDC's Antibiotic Resistance Laboratory Network, detected active-on-imipenem metallo-beta-lactamase (IMP) carbapenemase gene type 84 ($bla_{\text{IMP-84}}$) and characterized the isolate as multilocus sequence type 235 (ST235). IMP is one of the less commonly reported carbapenemase genes, all of which encode for enzymes that degrade carbapenems and other β-lactam antibiotics and are associated with multidrug-resistant phenotypes (*1*,*2*). The IDPH HAI program provided guidance to hospital A, including recommending submitting all CP-CRPA samples for testing.

On January 25, 2022, hospital A collected a third sputum specimen from a woman aged >65 years (patient 2), who occupied room X while receiving mechanical ventilation for 4 weeks. CP-CRPA was isolated only from this final serial specimen, suggesting hospital-acquired infection. On January 26, patient 2 was transferred to a long-term care facility (hospital B) and not placed on contact precautions during her 10-day stay. Hospital A sent a contact precaution recommendation based on CP-CRPA detection, but it was not directed to hospital B's infection preventionist.

No patients were placed in room X after the second clinical CP-CRPA isolate was reported. UPHL confirmed that patient 2's clinical isolate was ST235 with $bla_{\text{IMP-84}}$, which supported

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

† https://arpsp.cdc.gov/profile/arln/crpa

§ Four carbapenemase genes were tested by PCR: *Klebsiella pneumoniae* carbapenemase, New Delhi metallo-beta-lactamase, Verona integron-encoded metallo-beta-lactamase, and oxacillinase-48-like beta-lactamase.

epidemiologic linkage between patients. After the report of a second isolate with ST235 and *bla*$_{IMP-84}$, the IDPH HAI team planned an in-person visit to investigate this cluster associated with room X. During March 21–22, 2022, the team met with hospital A's infection prevention team to review policies, procedures, and patient histories. Between occupancies of patients 1 and 2, a total of 16 patients occupied room X for a median of 3.5 days (range = 1–12 days). Records showed that at least one respiratory specimen was cultured from each of five patients who occupied room X; however, no CP-CRPA was isolated from these specimens.

During this visit, the IDPH HAI team collected environmental samples based on consultation with CDC. Plumbing was sampled because *P. aeruginosa* persists in biofilm, which is a collection of microorganisms that are adherent to one another and to a surface, such as pipes. Water samples and swabs from two sinks and one toilet were collected from room X. Nondisposable parts of a ventilator used by patient 1 were swabbed. No ventilator used by patient 2 was available for testing. CP-CRPA ST235 with *bla*$_{IMP-84}$ was identified from one sink, including swab samples from the drain, p-trap (a bend in a drain pipe that contains water, which forms a seal to block entry of sewer gases), and counter; IMP+ *P. aeruginosa* was recovered from the p-trap water sample and one of seven toilet bowl water samples. After sequencing, all isolates were uploaded to BioProject PRJNA288601 and analyzed via Pathogen Detection (*3*); cluster PDS000105853.3 included all isolates from this investigation and no others as of May 23, 2023 (Supplementary Figure, https://stacks.cdc.gov/view/cdc/131485) (Supplementary Table 1, https://stacks.cdc.gov/view/cdc/131483). Clinical isolates were most similar to each other and the sink drain isolate with 14 and 16–22 single nucleotide polymorphism differences, respectively (Supplementary Table 2, https://stacks.cdc.gov/view/cdc/131484).

Screening for CP-CRPA colonization by rectal swab (by PCR[¶] and culture) or sputum sample of two other patients with current or recent stays in hospital A's ICU and 19 patients at hospital B was conducted during the week of March 14, 2022; no CP-CRPA was detected, suggesting no person-to-person transmission despite patient 2 not being on contact precautions at hospital B.

Public Health Response

The IDPH HAI team's recommendations to hospital A, in consultation with CDC, included the following: 1) close room X pending sink drain biofilm disinfection with a foam peracid mixture[**] EPA-registered for drain biofilm disinfection against *P. aeruginosa*, 2) add sink splash guards to reduce counter contamination from the drain, 3) add the disinfectant to weekly cleaning procedures for all ICU room drains, 4) introduce sink hygiene practices[††] such as designated handwashing sinks, 5) confirm that infection preventionists receive contact precaution recommendations after patient transfers, 6) collect screening specimens from room X occupants (e.g., the next 10 occupants or, if rarely occupied, occupants during a 3-month period) for CP-CRPA detection, and 7) continue submitting CRPA isolates to IBL. The disinfectant product was applied per manufacturer's instructions during May 9–27, 2022 (daily for 3 days and then every 3–5 days for four additional applications). Thirteen days after the seventh disinfectant application and 11 weeks after the initial visit, the IDPH HAI team collected swabs of the previously contaminated sink bowl and drain; *P. aeruginosa* was not isolated. As of December 2022, hospital A has reported no additional CRPA clinical isolates.

Discussion

This investigation highlights how collaboration among hospital A's surveillance program, public health HAI programs, and public health laboratories identified a cluster of CP-CRPA with *bla*$_{IMP-84}$ in two hospitalized patients, no evidence of person-to-person transmission, and one sink as the likely environmental source of CP-CRPA in an ICU room. Risk factors for CRPA include hospitalization, especially while receiving mechanical ventilation (*4*). Both patients in this cluster received prolonged mechanical ventilation and had routine serial sputum cultures for surveillance of infection-related ventilator-associated complications.[§§] Among the 16 patients hospitalized in room X between the occupancies of patient 1 and patient 2, only five had respiratory specimens cultured during hospitalization, and CP-CRPA was not isolated from any specimen; it is possible that the shorter stays (≤12 days) or lack of mechanical ventilation reduced transmission risk.

Whole genome sequencing of isolates strengthened evidence supporting linkage between patients. Because CP-CRPA persists in the environment, particularly in biofilms formed in premise plumbing (*5*), plumbing within room X was sampled; CP-CRPA isolates from samples collected from one sink were genetically similar to the clinical isolates. Addition of the disinfectant to the sink drain cleaning schedule appeared to be successful in eliminating CP-CRPA; however, optimal frequency of drain disinfection for disrupting CP-CRPA biofilm formation remains to be established, with findings from some studies suggesting that repeated application of disinfectant every 3–7 days could be effective in reducing gram-negative bacterial loads (*6*,*7*).

[¶] https://www.accessdata.fda.gov/cdrh_docs/pdf16/K160901.pdf
[**] https://www3.epa.gov/pesticides/chem_search/ppls/001677-00226-20200205.pdf

[††] https://www.cdc.gov/hai/prevent/environment/water.html
[§§] https://www.cdc.gov/nhsn/pdfs/pscmanual/10-vae_final.pdf

Summary

What is already known about this topic?

Treatment of carbapenemase-producing carbapenem-resistant *Pseudomonas aeruginosa* (CP-CRPA) infections is challenging because of antibiotic resistance. CP-CRPA infections are highly transmissible in health care settings because they can spread from person to person and from environmental sources.

What is added by this report?

CP-CRPA was detected in two patients who each spent approximately 1 month in the same intensive care unit (ICU) room, 4 months apart. Isolates from both patients contained a carbapenemase-producing gene. The same gene type was also detected in isolates from one of the ICU room sinks. Control measures included discontinuing room use pending sink drain biofilm disinfection.

What are implications for public health practice?

Multifaceted interventions, including sink hygiene practices, engineering controls, and administrative controls, are critical to limiting multidrug-resistant organism spread in health care settings.

Limitations

The findings in this report are subject to at least three limitations. First, although no colonization screening detected CRPA, screening was voluntary and limited to patients currently at either hospital A or B, which limited conclusions about the extent of transmission. Second, hypothesized mechanisms of transmission, including splash directly onto patient care items or contamination of health care personnel or visitors during sink use and subsequent transmission to patients, were not assessed. Finally, reporting and submission of CRPA isolates to IBL is voluntary, which limits knowledge regarding CRPA detection in Idaho.

Implications for Public Health Practice

Collaboration among hospital HAI staff members and public health agencies improved the strength of evidence supporting recommendations in a CP-CRPA HAI cluster investigation. Multifaceted interventions, including sink hygiene practices, engineering controls to minimize splashing, and administrative controls, are critical to limiting further spread of multidrug-resistant organisms in health care settings (*8*).

Acknowledgments

Staff members, hospital A and hospital B.

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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. Sheu CC, Chang YT, Lin SY, Chen YH, Hsueh PR. Infections caused by carbapenem-resistant *Enterobacteriaceae*: an update on therapeutic options. Front Microbiol 2019;10:80. PMID:30761114 https://doi.org/10.3389/fmicb.2019.00080
2. McKenna M. Antibiotic resistance: the last resort. Nature 2013;499:394–6. PMID:23887414 https://doi.org/10.1038/499394a
3. National Library of Medicine. Pathogen detection. Bethesda, MD: National Library of Medicine; National Center for Biotechnology Information; 2016. Accessed April 24, 2023. https://www.ncbi.nlm.nih.gov/pathogens/
4. Sabour S, Huang JY, Bhatnagar A, et al. Detection and characterization of targeted carbapenem-resistant health care–associated threats: findings from the Antibiotic Resistance Laboratory Network, 2017 to 2019. Antimicrob Agents Chemother 2021;65:e0110521. PMID:34570648 https://doi.org/10.1128/AAC.01105-21
5. Weingarten RA, Johnson RC, Conlan S, et al.; NISC Comparative Sequencing Program. Genomic analysis of hospital plumbing reveals diverse reservoir of bacterial plasmids conferring carbapenem resistance. MBio 2018;9:e02011–7. PMID:29437920 https://doi.org/10.1128/mBio.02011-17
6. Ramos-Castaneda JA, Faron ML, Hyke J, et al. How frequently should sink drains be disinfected? Infect Control Hosp Epidemiol 2020;41:358–60. PMID:31918767 https://doi.org/10.1017/ice.2019.316
7. Jones LD, Mana TSC, Cadnum JL, et al. Effectiveness of foam disinfectants in reducing sink-drain gram-negative bacterial colonization. Infect Control Hosp Epidemiol 2020;41:280–5. PMID:31801646 https://doi.org/10.1017/ice.2019.325
8. Parkes LO, Hota SS. Sink-related outbreaks and mitigation strategies in healthcare facilities. Curr Infect Dis Rep 2018;20:42. PMID:30128678 https://doi.org/10.1007/s11908-018-0648-3

Notes from the Field

Measles Outbreak — Central Ohio, 2022–2023

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On November 5, 2022, Columbus Public Health, Ohio and the Ohio Department of Health were notified of two children aged 2 years who were admitted to a central Ohio hospital with rash, fever, cough, and congestion, suggestive of measles. Both children were undergoing medical evaluation and treatment for other etiologies before measles was considered in the differential diagnosis. Neither child had received measles, mumps, and rubella (MMR) vaccine, and neither had known contact with a person with measles. Each patient subsequently received a positive measles real-time reverse transcription–polymerase chain reaction (RT-PCR) test result. Neither child had traveled internationally, but during June 12–October 8, 2022, four internationally imported measles cases had been confirmed among unvaccinated Franklin County, Ohio residents who had traveled to areas in East Africa where measles outbreaks were ongoing (*1*). Investigation of the U.S.-acquired measles cases identified additional measles cases, and local and state health departments confirmed a community outbreak on November 9, 2022. During this community measles outbreak in central Ohio, 85 locally acquired measles cases were confirmed with rash onsets during October 22–December 24, 2022; however, no definitive link to the previous international importations was established. The outbreak was declared over on February 4, 2023, 42 days (two measles incubation periods) after the last reported case.

Investigation and Outcomes

Suspected measles cases were investigated through patient, health care provider, and child care facility interviews, medical records review, and consultation with health care providers. Nasopharyngeal swab and serum specimens were collected in accordance with recommendations.* The 85 confirmed cases included 78 in Franklin County, two in Madison County, and one each in Clark, Fairfield, Richland, Ross, and Union counties, all counties within central Ohio. The Ohio Department of Health Public Health Laboratory performed RT-PCR testing of specimens from 193 persons during the outbreak; 74 (87%) measles cases were laboratory-confirmed,† and the remaining 11 (13%) were epidemiologically linked to confirmed cases. Among 65 genotyped specimens, all were genotype B3. The median patient age was 1 year (range = 6 months–15 years). Eighty (94%) patients had not received MMR vaccine. Sixty (71%) patients were aged ≥1 year and age-eligible for routine MMR vaccination,§ but only three (5%) had documentation of receipt of 1 MMR vaccine dose at the time of infection¶; vaccination status of one (2%) patient was unknown.

Forty-four (52%) of the 85 measles patients experienced complications, including otitis media (33; 39%), diarrhea (22; 26%), and pneumonia (seven; 8%); 36 (42%) patients were hospitalized, predominately for dehydration.** The median length of hospitalization was 3 days (range = 1–7 days). Twelve hospitalized patients had coinfections with other respiratory pathogens (e.g., respiratory syncytial virus [RSV]).†† No deaths were reported.

Reported exposure locations for measles included five health care facilities accounting for 32 (38%) of 85 total cases, four child care facilities with 22 (26%) cases, and households with 17 (20%) cases (Figure). This outbreak occurred during a peak in emergency department visits for COVID-19, RSV, and influenza (*2*).

Columbus Public Health and Franklin County Public Health departments identified 739 local contacts who were unvaccinated or had unknown vaccination status and required quarantine; 446 (60%) were successfully enrolled in active monitoring. Among these 446 persons, 43 (10%) developed measles during quarantine, 28 (65%) of whom were reached before rash onset. Postexposure prophylaxis was administered to 59 contacts, including eight (14%) who received MMR vaccine, and 51 (88%) who received immune globulin.§§ Two children who received MMR vaccine and none who received immune globulin were later diagnosed with measles.

* https://www.cdc.gov/vaccines/pubs/surv-manual/chpt07-measles.html

† The 74 laboratory-confirmed cases included 71 with RT-PCR–positive results and three with immunoglobulin M–positive results.

§ The Advisory Committee on Immunization Practices recommends 2 routine MMR vaccine doses for children, with the first dose administered at age 12–15 months and the second dose at age 4–6 years, before school entry.

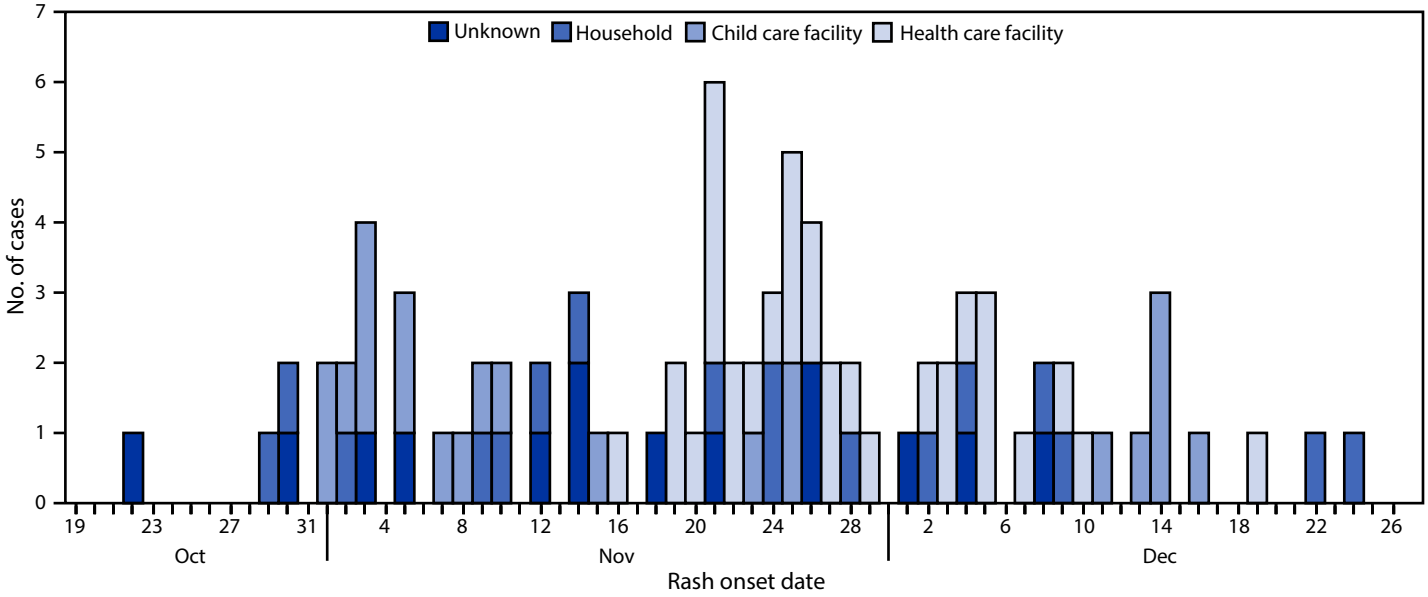
¶ One patient received MMR vaccine 35 months before known exposure; one patient received MMR vaccine ≤72 hours after known exposure; and one patient with an unknown exposure date received MMR vaccine 9 days before rash onset.

** Reasons for admission obtained from medical records.

†† Identified respiratory pathogens included adenovirus, group A Streptococcus, influenza A, rhinovirus, enterovirus, RSV, and SARS-CoV-2.

§§ MMR vaccine administered ≤72 hours after exposure; immune globulin administered ≤6 days after exposure.

FIGURE. Measles cases, by rash onset date and exposure locations (N = 85) — Central Ohio, October–December 2022



Preliminary Conclusions and Actions

Ohio previously experienced a measles outbreak in 2014. During 2021–2022, kindergarten-entry 2-dose MMR vaccination coverage in Ohio (88.3%) was approximately 5% lower than the national estimate of 93.0% (*3*). Although measles was declared eliminated in the United States in 2000,¶¶ it remains endemic in many countries, and internationally imported cases continue to be associated with outbreaks among undervaccinated, close-knit communities in the United States (*4*). This outbreak was characterized by young median patient age, low rates of MMR vaccination, and high rates of respiratory coinfection, with twice the hospitalization rate reported among previous measles cases in the United States (*5*).

This outbreak serves as a reminder that health care facilities, medical providers, and child care facilities serving undervaccinated populations should maintain vigilance for measles and emphasize the importance of timely MMR vaccination. Sustaining elimination of measles in the United States will require continued high 2-dose MMR vaccination coverage in all communities.

¶¶ The World Health Organization defines measles elimination as the absence of endemic measles virus transmission in a defined geographic area (e.g., region or country) for ≥12 months in the presence of a surveillance system that has been verified to be performing well. https://www.cdc.gov/measles/elimination.html

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References

1. World Health Organization. Immunization analysis and insights. Provisional monthly measles and rubella data. Geneva, Switzerland: World Health Organization; 2023. Accessed March 13, 2023. https://www.who.int/teams/immunization-vaccines-and-biologicals/immunization-analysis-and-insights/surveillance/monitoring/provisional-monthly-measles-and-rubella-data
2. CDC. NCIRD surveillance. National emergency department visits for COVID-19, influenza, and respiratory syncytial virus. Atlanta, GA: US Department of Health and Human Services, CDC; 2023. Accessed March 13, 2023. https://www.cdc.gov/ncird/surveillance/respiratory-illnesses/index.html
3. Seither R, Calhoun K, Yusuf OB, et al. Vaccination coverage with selected vaccines and exemption rates among children in kindergarten—United States, 2021–22 school year. MMWR Morb Mortal Wkly Rep 2023;72:26–32. PMID:36634005 https://doi.org/10.15585/mmwr.mm7202a2
4. Mathis AD, Clemmons NS, Redd SB, et al. Maintenance of measles elimination status in the United States for 20 years despite increasing challenges. Clin Infect Dis 2022;75:416–24. PMID:34849648 https://doi.org/10.1093/cid/ciab979
5. Gastañaduy PA, Funk S, Lopman BA, et al. Factors associated with measles transmission in the United States during the postelimination era. JAMA Pediatr 2020;174:56–62. PMID:31738391 https://doi.org/10.1001/jamapediatrics.2019.4357

Notes from the Field

Safety Monitoring of Novavax COVID-19 Vaccine Among Persons Aged ≥12 Years — United States, July 13, 2022–March 13, 2023

Brittney Romanson, MPH[1]; Pedro L. Moro, MD[1]; John R. Su, MD, PhD[1]; Paige Marquez, MSPH[1]; Narayan Nair, MD[2]; Brendan Day, MD[2]; Allison DeSantis, MPH[3]; Tom T. Shimabukuro, MD[1]

The NVX-CoV2373 (Novavax) COVID-19 vaccine is a recombinant spike protein nanoparticle vaccine with Matrix-M adjuvant. Novavax is authorized and recommended as a primary 2-dose monovalent vaccination series in persons aged ≥12 years to prevent COVID-19 and as a monovalent booster dose in persons aged ≥18 years who are unable to or unwilling to receive an mRNA COVID-19 bivalent vaccine (*1*).

Investigation and Outcomes

During July 13, 2022–March 13, 2023, a total of 69,227 Novavax doses were administered to persons aged ≥12 years in the United States, and 230 reports of adverse events (AEs) after Novavax vaccination were received by the Vaccine Adverse Event Reporting System (VAERS) (*2*). The median age of patients in the reports was 45 years (IQR = 31–61 years); 152 (66.1%) reports concerned females, and 104 (45.2%) concerned non-Hispanic White persons (Table). Within the study period, VAERS received no reports concerning pregnant women. Most VAERS reports (211; 91.7%) were classified as nonserious.* The most commonly reported AEs included dizziness (33; 14.3%), fatigue (26; 11.3%), and headache (25; 10.9%).

Among the 230 reports received, 19 (8.3%) were classified as serious; no deaths were reported after vaccination. Serious reports included one case of thrombosis, two of pericarditis, one of Guillain-Barré syndrome, and two of seizure; available medical records for these reports were reviewed. The remaining serious reports described chest pain, arrhythmia, sickness, hospitalization, adverse event not otherwise specified, balance disorder, peripheral neuropathy aggravated, and vaccine failure. The reports were primarily manufacturer reports with no records available for review. The report of thrombosis described a female with axillary-subclavian thrombosis occurring 6 days after vaccination; medical history suggested other

*VAERS reports are classified as serious if any of the following are reported: hospitalization, prolongation of hospitalization, life-threatening illness, permanent disability, congenital anomaly or birth defect, or death. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr

TABLE. Demographic characteristics in reports of adverse events after primary Novavax COVID-19 vaccination in persons aged ≥12 years* and most frequent Medical Dictionary for Regulatory Activities Preferred Terms† in reports — Vaccine Adverse Event Reporting System, United States, July 13, 2022–March 13, 2023

Characteristic	Report classification, no. (%)		
	Serious§ (n = 19)	Nonserious (n = 211)	Total (N = 230)
Sex			
Female	12 (63.2)	140 (66.4)	**152 (66.1)**
Male	6 (31.6)	65 (30.8)	**71 (30.9)**
Unknown	<3 (5.3)	6 (2.8)	**7 (3.0)**
Age group, yrs			
12–17	0 (—)	5 (2.4)	**5 (2.2)**
18–49	8 (42.1)	111 (52.6)	**119 (51.7)**
50–64	6 (31.6)	58 (27.5)	**64 (27.8)**
≥65	5 (26.3)	37 (17.5)	**42 (18.3)**
Race and ethnicity			
American Indian or Alaska Native, NH	0 (—)	0 (—)	**0 (—)**
Asian, NH	<3 (5.3)	7 (3.3)	**8 (3.5)**
Asian, unknown ethnicity	0 (—)	<3 (0.5)	**<3 (0.4)**
Black or African American, NH	<3 (5.3)	8 (3.8)	**9 (3.9)**
Native Hawaiian or other Pacific Islander, NH	<3 (5.3)	0 (—)	**<3 (0.4)**
White, NH	12 (63.2)	92 (43.6)	**104 (45.2)**
White, unknown ethnicity	0 (—)	15 (7.1)	**15 (6.5)**
Hispanic or Latino**	0 (—)	24 (11.4)	**24 (10.4)**
Multiple races, NH	0 (—)	<3 (1.0)	**<3 (0.9)**
Unknown race, NH	0 (—)	<3 (1.0)	**<3 (0.9)**
Unknown race, unknown ethnicity	4 (21.1)	58 (27.5)	**62 (27.0)**
MedDRA PT††			
Chest pain	3 (15.8)	14 (6.6)	**17 (7.4)**
Dizziness	5 (26.3)	28 (13.3)	**33 (14.3)**
Fatigue	4 (21.1)	22 (10.4)	**26 (11.3)**
Fever	<3 (5.3)	15 (7.1)	**16 (7.0)**
Headache	3 (15.8)	22 (10.4)	**25 (10.9)**
Incorrect dose administered	0 (—)	16 (7.6)	**16 (7.0)**
Incorrect product formulation administered	0 (—)	16 (7.6)	**16 (7.0)**
Interchange of vaccine products	0 (—)	18 (8.5)	**18 (7.8)**
Nausea	3 (15.8)	16 (7.6)	**19 (8.3)**
Pain	0 (—)	19 (9.0)	**19 (8.3)**

Abbreviations: MedDRA PT = Medical Dictionary for Regulatory Activities Preferred Term; NH = non-Hispanic; VAERS = Vaccine Adverse Event Reporting System.

* Reports for persons aged ≥18 years were received by VAERS and had vaccination dates during July 13, 2022–March 13, 2023; reports for persons aged 12–17 years were received and had vaccination dates during August 19, 2022–March 13, 2023; includes reports with missing vaccination dates. When fewer than three reports were received within a category, the number is noted as "<3" to prevent inadvertent identification of the vaccine recipient.

† https://www.meddra.org/how-to-use/basics/hierarchy

§ VAERS reports are classified as serious if any of the following are reported: hospitalization, prolongation of hospitalization, life-threatening illness, permanent disability, congenital anomaly or birth defect, or death. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr

** Includes Hispanic or Latino ethnicity of unknown race.

†† Not mutually exclusive.

potential causes (e.g., use of oral contraceptives). One of the two reports of pericarditis described a male aged 40–49 years with an abnormal electrocardiogram and simple circumferential pericardial effusion 3 days after vaccination; medical history suggested potential underlying causes (e.g., multiple previous SARS-CoV-2 infections, including with the Omicron B.1.1.529 variant). The second pericarditis report did not meet the CDC case definition for myocarditis or pericarditis (*3*). No records were available for the report of Guillain-Barré syndrome. Records were available for one report of seizure, which described new seizure onset in an adolescent who met the Brighton Collaboration case definition for seizure.†

Sixty-six (28.7%) reports were for vaccination errors, all classified as nonserious, including three (4.5%) documenting an AE (e.g., fever and fatigue). The most commonly reported vaccination error was administration of a (not yet authorized) booster dose of Novavax instead of an mRNA COVID-19 vaccine (21; 31.8%).

Preliminary Conclusions and Recommendations

Although postauthorization safety data after receipt of a primary Novavax dose are limited by the low number of doses administered (0.01% of total COVID-19 vaccine doses administered) (*2*), available data are consistent with those from preauthorization clinical trials.§ No new safety concerns were identified. Limitations of this analysis include reporting biases and inconsistency in the quality and completeness of reports to VAERS (*4*). VAERS data generally cannot be used to determine whether a vaccine caused an adverse event. In addition, approximately one half of the reports representing adverse events of special interest lacked medical records for CDC review.

Vaccine administration errors are largely preventable with proper education and training. To help ensure proper vaccine administration, use of a prevaccination checklist is recommended.¶ In general, the same vaccine product is recommended for all doses of primary COVID-19 vaccination series, with certain exceptions (e.g., inability to receive an mRNA vaccine).** These measures can help persons stay up to date with recommended COVID-19 vaccinations, which will reduce illness and death from this serious disease.

† https://brightoncollaboration.us/generalized-convulsion-case-definition-companion-guide

§ https://www.fda.gov/media/159897/download

¶ https://www.cdc.gov/vaccines/covid-19/downloads/pre-vaccination-screening-form.pdf

** https://www.cdc.gov/vaccines/acip/recs/grade/covid-19-novavax-adult-booster-etr.html

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References

1. Twentyman E, Wallace M, Roper LE, et al. Interim recommendation of the Advisory Committee on Immunization Practices for use of the Novavax COVID-19 vaccine in persons aged ≥18 years—United States, July 2022. MMWR Morb Mortal Wkly Rep 2022;71:988–92. PMID:35925807 https://doi.org/10.15585/mmwr.mm7131a2
2. CDC. COVID data tracker. Atlanta, GA: US Department of Health and Human Services, CDC; 2023. Accessed March 28, 2023. https://covid.cdc.gov/covid-data-tracker
3. Gargano JW, Wallace M, Hadler SC, et al. Use of mRNA COVID-19 vaccine after reports of myocarditis among vaccine recipients: update from the Advisory Committee on Immunization Practices—United States, June 2021. MMWR Morb Mortal Wkly Rep 2021;70:977–82. PMID:34237049 https://doi.org/10.15585/mmwr.mm7027e2
4. Shimabukuro TT, Nguyen M, Martin D, DeStefano F. Safety monitoring in the Vaccine Adverse Event Reporting System (VAERS). Vaccine 2015;33:4398–405. PMID:26209838 https://doi.org/10.1016/j.vaccine.2015.07.035

Erratum

Vol. 72, No. 15

The report, "Epidemiologic and Clinical Features of Mpox-Associated Deaths — United States, May 10, 2022–March 7, 2023," contained several errors.

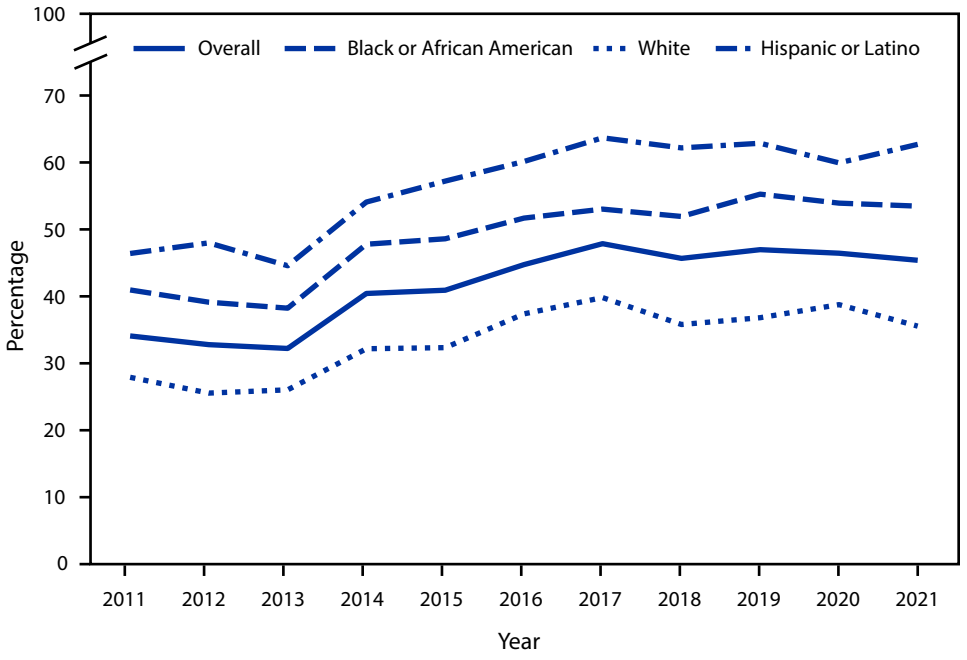
On page 407, in Table 1, the eleventh row heading should have read, "Received **smallpox** vaccine[§§]," and under the column "Decedents (n = 38)," the number and percentage for the row listed under "Yes" should have read **1 (7.7)¶¶**. On page 407, under the footnotes for Table 1, the seventh footnote, denoted by the double section sign (§§), should have read, **"**§§ At least 1 dose **of smallpox or JYNNEOS vaccine. Among some vaccine recipients, it is difficult to distinguish when vaccine was received and whether indication for use was prevention of smallpox or mpox."** A newly added eighth footnote, denoted by the double paragraph symbol (¶¶), should have read, **"¶¶ One person who died reported receiving smallpox vaccination in childhood, even though this decedent was aged <50 years (routine smallpox vaccination ended in the United States in 1972)."**

On page 409, the list of acknowledgments should have read, "Health care providers caring for mpox patients; public health responders from U.S. state and local departments of health; Isaac Ghinai, Janna L. Kerins, Massimo Pacilli, Hillary Spencer, Irina Tabidze, Chicago Department of Health; Rafael M. Mendoza, Jenniffer Rivas, Florida Department of Health in Broward County; Kristine Aviles, Florida Department of Health in Hillsborough County; Elizabeth Feinstone, Kristy Flom, Florida Department of Health in Osceola County; Madison Asbell, Cyndy Fohrman, Brenda Parduhn, Kira Richardson, Indiana Department of Health; Darby McDermott, Mojisola Ojo, Alex X. Zhang, New Jersey Department of Health; Courtney Dewart, CDC and Ohio Department of Health; Kara Tarter, Ohio Department of Health; **Haley Blake, Southern Nevada Health District**; Kevin Morris, Caleb Wiedeman, Tennessee Department of Health; Rania Milleron, Texas Department of State Health Services; Laura Bachmann, Adelaide Balenger, Denisse Descamps, Romeo R. Galang, Kaylea Nemechek, Suzanne Newton, Sheila Roy, Ruth Stefanos, CDC; CDC Clinical Escalations Team and health department personnel who consulted CDC for complicated cases of mpox; CDC clinical officers who perform consultations."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage of Emergency Department Visits* with Medicaid as the Primary Expected Source of Payment Among Persons Aged <65 Years, by Race and Ethnicity† — National Hospital Ambulatory Medical Care Survey, United States, 2011–2021



Abbreviation: ED = emergency department.

* Based on a sample of visits to EDs in noninstitutional general and short-stay hospitals, excluding federal, military, and Veterans Administration hospitals, located in 50 states and the District of Columbia.

† Visits by non-Hispanic persons of other races are not displayed but are included in overall percentages. Race groups are non-Hispanic. Data for race and ethnicity were imputed to account for missing data. Missing data on race and ethnicity among persons aged <65 years ranged from 15.3% to 22.1% and 10.4% to 31.0%, respectively, depending on the year. Expected source of payment refers to the sources of payment listed in the medical record as those sources expected to pay for the sampled visit at the time of data collection. Primary expected source of payment was based on a hierarchical recoding of multiple payment sources. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHAMCS/doc21-ed-508.pdf

During 2011–2021, the percentage of ED visits among persons aged <65 years with Medicaid as the primary expected source of payment increased from 34.0% to 45.3%. This pattern was consistent irrespective of race and Hispanic or Latino (Hispanic) origin. ED visits among Hispanic persons increased the most, from 46.3% in 2011 to 62.7% in 2021. The percentage of ED visits by persons with Medicaid as their primary expected source of payment increased from 40.9% in 2011 to 53.4% in 2021 among Black or African American (Black) persons, and from 27.8% to 35.5% among White persons. During the study period, the percentages of ED visits among Black and Hispanic persons with Medicaid as the primary expected source of payment were higher than the percentages of visits by White persons.

Source: National Center for Health Statistics, National Hospital Ambulatory Medical Care Survey, 2011–2021. https://www.cdc.gov/nchs/ahcd/index.htm

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