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Outbreak Linked to Morel Mushroom Exposure — Montana, 2023

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Abstract

During March–April 2023, a total of 51 persons reported mild to severe gastrointestinal illness after eating at restaurant A in Bozeman, Montana. The outbreak resulted in multiple severe outcomes, including three hospitalizations and two deaths. After an inspection and temporary restaurant closure, the Montana Department of Public Health and Human Services and Montana's Gallatin City-County Health Department collaborated with CDC to conduct a matched case-control study among restaurant patrons to help identify the source of the outbreak. Consumption of morel mushrooms, which are generally considered edible, was strongly associated with gastrointestinal illness. A dose-response relationship was identified, and consumption of raw morel mushrooms was more strongly associated with illness than was consumption of those that were at least partially cooked. In response to the outbreak, educational public messaging regarding morel mushroom preparation and safety was shared through multiple media sources. The investigation highlights the importance of prompt cross-agency communication and collaboration, the utility of epidemiologic studies in foodborne disease outbreak investigations, and the need for additional research about the impact of morel mushroom consumption on human health. Although the toxins in morel mushrooms that might cause illness are not fully understood, proper preparation procedures, including thorough cooking, might help to limit adverse health effects.

Introduction

On April 18, 2023, the Montana Department of Public Health and Human Services (MTDPHHS) and health departments in Gallatin and Broadwater counties were notified of two persons who experienced severe nausea, vomiting, and diarrhea after separately dining at restaurant A in Bozeman, Montana on April 17. One restaurant patron was hospitalized and later died; the second died hours after being discharged from a hospital emergency department. Both persons experienced symptom onset within 60 minutes of their meal. These reports prompted an immediate restaurant inspection on April 18 by the Gallatin City-County Health Department (GCCHD) and a temporary closure of restaurant A. On the basis of the rapid onset of symptoms in the hospitalized patient, the provider suspected a foodborne toxin as the source of illness and sought clinical consultation from Rocky Mountain Poison and Drug Safety (https://www.rmpds.org/) for testing and treatment recommendations. On April 19, MTDPHHS requested assistance from CDC and the Food and Drug Administration (FDA).

Investigation and Findings

Identification of Index Patients and Implicated Foods

Investigation of the two index patients revealed that both persons had consumed a special sushi roll containing salmon and morel mushrooms. Morels were a new menu ingredient and were the only ingredient unique to the special sushi roll, making it an early suspected source of the outbreak. The morels were prepared in various ways during March 27–April 17.

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On April 8, morels were served partially cooked: a hot boiled sauce was poured over the raw morels, after which they were marinated for 75 minutes. On April 17, the morels were uncooked and cold-marinated before serving. During an inspection of restaurant A on April 18, food samples were collected, including salmon and morel pieces remaining from the original packaging. Multiple violations were identified at the time of inspection, including temperature control issues, improper time control and sanitization procedures, and improper storage of personal items. On the basis of the thorough environmental inspection and collection of food samples, clinical presentation of index patients, and early evidence implicating a specific food item, investigators determined that environmental sample collection was not necessary. On April 19, restaurant A informed GCCHD that it had received four additional telephone calls from patrons reporting illness after consumption of the special sushi roll. Other patrons reported illness directly to GCCHD throughout the investigation.

Clinical Characteristics of Ill Persons

After a May 3 press release providing an update on the outbreak and soliciting additional cases, GCCHD continued to receive reports of gastrointestinal illness related to eating at restaurant A between March 28 and April 17. In total, the investigation identified 51 cases of illness* (including five cases among employees and 46 among restaurant patrons); of these cases, four ill persons visited a hospital emergency department, three were hospitalized, and the two index patients died (including one who sought emergency care but was not hospitalized). Among the 51 ill persons, 45 (88%) reported consumption of morels at restaurant A. Review of medical records for the three persons who were hospitalized and one person who sought emergency medical care without hospitalization revealed that the onset of gastrointestinal symptoms was rapid, with a median symptom onset of 1 hour after the restaurant meal. Vomiting and diarrhea were reportedly profuse, and hospitalized patients had clinical evidence of dehydration. The two patients who died had chronic underlying medical conditions that might have affected their ability to tolerate massive fluid loss.

Testing of Clinical and Food Specimens

MTDPHHS and GCCHD coordinated with FDA for food specimen testing and with CDC's toxicology and enteric

*Initially, a case was defined as the occurrence of gastrointestinal illness or neurologic symptoms in a person after eating at restaurant A during March 27–April 18, 2023, and the interval between these dates was considered the potential exposure period. However, follow-up indicated that all ill persons ate at the restaurant during March 28–April 17, 2023.

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diseases groups for clinical specimen testing.[†] Food specimens were tested for multiple substances, including volatile and nonvolatile organic compounds and enteric pathogens.[§] Neither clinical testing nor food testing identified a causative agent.

Traceback of Implicated Food Items

Health department sanitarians traced the morels to a single importer, and a separate distributor that supplied mushrooms to multiple states. The morel mushrooms were cultivated and imported fresh from China. FDA and the California Department of Public Health contacted 12 California facilities that received morels from the same importer during January 1–May 17, 2023, six of which responded to the inquiries and reported receiving no illness complaints from patrons who ate morels prepared and served by those facilities. All six facilities reported cooking or otherwise thoroughly heating the morels before they were served. A CDC Epidemic Information Exchange (Epi-X) multistate call for cases did not result in additional case reports.

Matched Case-Control Study

To identify foods associated with illness and assess a possible dose-response relationship, MTDPHHS and GCCHD, with support from CDC, conducted a matched case-control study. A questionnaire solicited demographic and symptom information and food items consumed.[¶] A case was defined as the occurrence of diarrhea, nausea, vomiting, or abdominal pain in a person any time after eating at restaurant A during March 27–April 18, 2023. Cases were identified through reports received by restaurant A, public health departments, and case-patient interviews. Control participants were identified during case-patient interviews as dining partners who did not report illness after eating at restaurant A. Case-patients (or a proxy) and control participants were interviewed during May 4–12, 2023.

State and county health department staff members collected questionnaire data using Jotform software (version 4.0; Jotform Inc.). Deidentified data were sent to CDC for analysis. CDC personnel conducted matched and unmatched logistic regression analyses using SAS software (version 9.4; SAS Institute). This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[**]

A total of 41 case-patients[††] and 22 control participants responded to the questionnaire and were included in analyses, representing 29 unique dining parties. Overall, 27 (36.9%) case-patients were female and 31 (75.6%) were aged 20–49 years. A majority reported diarrhea (37; 90.2%), nausea (34; 82.9%), abdominal pain (28; 68.3%), loss of appetite (25; 61.0%), fatigue (24; 58.5%), vomiting (22; 53.7%), and abdominal distension (22; 53.7%) (Table 1).

In logistic regression analyses matched on dining party, the odds of eating the special sushi roll with morels among case-patients were 15.78 times higher than the corresponding odds among control participants (Table 2). In addition, the odds of eating any morels among case-patients were 10.77 times higher than the corresponding odds among control participants. Other foods did not appear to be associated with case status.

When the amount of the special sushi roll consumed was modeled continuously, the association was positive between a one-piece increase in consumption of the special sushi roll and case status in all analyses (Table 2). When the special sushi roll was modeled as a three-level categorical variable (none, one–three pieces of a roll, and four pieces of a roll or more), associations in the unmatched models also suggested a dose-response relationship.[§§]

In models stratified by meal date, odds ratios comparing the odds of eating the special sushi roll (yes versus no) among 27 case-patients and 18 control participants were higher among those who ate at the restaurant on April 17, when uncooked morels were served, relative to April 8, when the morels reportedly underwent a partial cooking process (Table 3).

[†] Clinical testing for persons with specimens available included urine amatoxin testing, random total urine arsenic level, stool gastrointestinal panel and culture, and standard clinical laboratory tests used for medical management. Results of laboratory testing did not identify a causative agent.

[§] Salmon and morel mushroom specimens tested negative for various known toxins, heavy metals, pesticides, volatile and nonvolatile organic substances, and pathogens, including *Clostridium perfringens, Bacillus cereus*, *Staphylococcal enterotoxin,* and other common enteric pathogens. DNA sequencing identified the mushroom specimen as *Morchella sextelata,* a species of true morel.

[¶] The questionnaire included details related to dining (e.g., date and foods and beverages consumed), new or worsened symptoms after dining, receipt of medical care for those symptoms, underlying medical conditions, and dining partners. The survey accounted for the amount of each food eaten, menu modifications, unlisted food items (e.g., daily specials, chef's choice, and "secret menu" items) and whether morel mushrooms were included in any food items. A proxy dining partner was interviewed to obtain information on one of the case-patients who was deceased.

[**] 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.

[††] Among the 42 case-patients eligible for the case-control study, two were lost to follow-up, and one was deceased with no available proxy to interview. Two control participants were later found to have met the case definition and were reclassified as case-patients.

[§§] An employee cohort study was also completed but had a small sample size. Eleven employees were interviewed, four of whom reported illness that met the case definition. Employees were not included in the case-control study. Employees who reported eating more pieces of the special sushi roll were more likely to report illness (Cochran-Armitage trend test two-sided exact p-value = 0.033). Using exact logistic regression, the odds ratio per one piece of special sushi roll increase was 1.92 (95% CI = 0.97–6.77; p-value = 0.067).

TABLE 1. Characteristics of case-patients and control participants who dined at restaurant A — Montana, May 2023

Characteristic	No. (%) Case-patients n = 41	No. (%) Control participants n = 22
Sex		
Female	27 (65.9)	12 (54.5)
Male	14 (34.1)	10 (45.5)
Age group, yrs		
<20	0 (—)	4 (18.2)
20–49	31 (75.6)	12 (54.5)
≥50	10 (24.4)	6 (27.3)
Signs and symptoms*		
Diarrhea	37 (90.2)	NA
Nausea	34 (82.9)	NA
Abdominal pain	28 (68.3)	NA
Loss of appetite	25 (61.0)	NA
Fatigue	24 (58.5)	NA
Vomiting	22 (53.7)	NA
Abdominal distension or bloating	22 (53.7)	NA
Lightheadedness	18 (43.9)	NA
Dizziness	16 (39.0)	NA
Headaches†	15 (37.5)	NA
Chills	14 (34.1)	NA
Other characteristics and outcomes		
Hours from meal to symptom onset, median, range†	1 (0.25–90.00)	NA
Hours from meal to symptom resolution, median, range†	24 (1.00–672.00)	NA
Contacted a physician for symptoms	6 (14.60)	NA
Hospitalized for symptoms	3 (7.30)	NA
Deceased§	1 (2.40)	NA

Abbreviation: NA = not applicable.
* Reported by at least one third of case-patients. Case-patients could report multiple signs or symptoms.
† Data missing for one case-patient.
§ One additional case-patient died but was not included in the case-control study because no proxy was available.

Public Health Response

In response to this outbreak, FDA published information on morels and other mushrooms that are traditionally wild and foraged but can also be cultivated (*1*). MTDPHHS and GCCHD published a press release summarizing the investigation's findings and provided recommendations on how to properly store and prepare morels to reduce the risk for illness (*2*). Restaurant A reopened to the public on May 25 once it was determined that public health risk had been mitigated by addressing health code violations. Restaurant A elected to stop serving morels.

Discussion

The findings from this investigation suggest that uncooked or undercooked morel mushrooms were the likely source of the outbreak. The epidemiologic study demonstrated a clear association between consumption of the special sushi roll with morels and gastrointestinal illness, including a dose-response relationship, and an apparent stronger association among persons who ate the morels on a day when the morels served by restaurant A were reportedly uncooked. The California Department of Public Health and FDA investigation also supported the potential impact of preparation method on health outcomes, because no gastrointestinal illnesses were reported among patrons who ate morels at facilities where they were cooked before serving.

The signs and symptoms reported by ill persons and documented in medical records, including gastrointestinal illness and dizziness, are consistent with those reported in association with consumption of improperly handled, prepared, or cooked

TABLE 2. Exact logistic regression models for associations between consumption of menu items and case-patient status of restaurant A patrons — Montana, May 2023

Exposure	No. of case-patients n = 41	No. of control participants n = 22	OR (95% CI) Matched analysis Model 1*	OR (95% CI) Unmatched analysis Model 2†	OR (95% CI) Unmatched analysis Model 3§
Any morels					
Yes	36	10	10.77 (1.37 to 492.84)	8.28 (2.12 to 37.80)	14.60 (2.75 to 151.00)
No	5	12	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Any special roll¶					
Yes	33	8	15.78 (3.11 to ∞)**	6.95 (1.97 to 27.20)	34.30 (4.17 to >1,000)
No	8	14	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
No. of pieces of special roll					
None	8	14	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
1–3	9	7	0.50 (0.03 to ∞)**	2.20 (0.50 to 10.24)	18.06 (1.34 to >1,000)
≥4	24	1	22.47 (4.34 to ∞)**	38.15 (4.57 to >1,000)	248.46 (31.25 to ∞)**
Odds per each additional piece of special roll consumed	—	—	2.88 (1.34 to 16.90)	2.06 (1.44 to 3.23)	4.99 (2.06 to 24.95)

Abbreviations: OR = odds ratio; Ref = referent group.
* Conducted using conditional logistic regression models (matched on dining party). Only matched dining parties with at least one case-patient and one control participant contributed to the analysis; therefore, the numbers in the table do not match those in the matched analysis.
† Unadjusted model.
§ Model adjusts for meal date (April 8–17, 2023 versus other) and age (continuous).
¶ Special roll is a sushi roll prepared with morel mushrooms.
** Indicates a median unbiased estimate.

TABLE 3. Associations* between consumption of special sushi roll and restaurant A patron case-patient status, by meal date — Montana, May 2023

Meal date	Consumed special roll†	No. of case-patients	No. of control participants	Unmatched analysis, OR§ (95% CI)
Apr 8	Yes	7	4	11.67 (0.67 to ∞)
	No	0	3	1.00 (—)
Apr 17	Yes	20	3	99.57 (8.60 to ∞)
	No	0	8	1.00 (—)

Abbreviation: OR = odds ratio.
* Based on the common OR and exact 95% CIs.
† Special roll is a sushi roll prepared with morel mushrooms.
§ The logit estimators use a correction of 0.5 in every cell.

morels. Previous reports have described gastrointestinal illness after consumption of morels, which were consumed raw or cooked to varying degrees, as well as neurologic symptoms, including cerebellar effects, and, in some cases, death (*3*–*6*).

Morels should be refrigerated at a temperature of ≤40°F (≤4.4°C), in breathable type packaging, such as a paper bag. Morels should be cooked thoroughly before consumption because cooking is likely to reduce toxin levels present in the mushrooms (*1*).

Limitations

The findings in this report are subject to at least five limitations. First, this investigation could not determine the specific characteristic of the morels that caused the outbreak. Morel storage and preparation methods, in addition to the differences in cooking methods described, that were not identified during the outbreak investigation might have differed between April 8 and 17, and might have played a role in causing illness. Second, morel mushroom toxins are not well characterized; therefore, the presence of a specific toxin could not be confirmed through laboratory testing (*1*). Third, limitations inherent to the epidemiologic studies included the small sample size and the possibility of unidentified confounding by something closely associated with the morels. Fourth, the study could have been affected by differential exposure misclassification (e.g., if case-patients had better recall of what they ate compared with control participants). Finally, responses could have been biased by public knowledge that morels were the suspected cause of illness.¶¶

Implications for Public Health Practice

The investigation of this outbreak demonstrated how a coordinated collaborative public health response including local, state, and federal agencies can preserve and promote public safety. These findings also highlight gaps in knowledge regarding morels that need further research to better understand how they affect human health, and to identify effective treatment for morel toxicity beyond supportive care. Morel mushrooms should be cooked before human consumption to mitigate their potential toxicity.

Summary

What is already known about this topic?

Although morel mushrooms are generally considered edible, rare cases of illness have been reported after consumption; little is known about the human health effects of morels. During March–April 2023, a total of 51 persons reported gastrointestinal illness after dining at a Montana restaurant; two patients died.

What is added by this report?

A case-control study identified morel mushrooms as the likely outbreak source. Consumption of raw morels was more strongly associated with illness than was consumption of cooked or partially cooked morels.

What are the implications for public health practice?

This outbreak investigation highlights the importance of prompt cross-agency communication, collaboration, and the use of epidemiologic studies to guide outbreak investigations. Morel mushrooms should be cooked before eating to mitigate potential toxic effects.

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¶¶ Early in the investigation, morel mushrooms were publicly discussed as being a suspected cause of the outbreak, through media and social media channels. GCCHD and MTDPHHS mentioned morels as being a suspected cause of the outbreak in a press release on May 3, which was before most of the interviews were conducted.

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References

1. Food and Drug Administration. Investigation of illnesses: morel mushrooms (May 2023). Silver Spring, MD: US Department of Health and Human Services, Food and Drug Administration; 2023. https://www.fda.gov/food/outbreaks-foodborne-illness/investigation-illnesses-morel-mushrooms-may-2023
2. Montana Department of Public Health and Human Services; Gallatin City-County Health Department. DPHHS and GCCHD provide final summary on foodborne outbreak linked to morel mushrooms. Helena, MT: Montana Department of Public Health and Human Services; 2023. https://dphhs.mt.gov/News/2023/July/FinalSummaryonMorelMushroomsFoodbourneOutbreak
3. Beug M, Shaw M, Cochran KW. Thirty-plus years of mushroom poisoning: summary of the approximately 2,000 reports in the NAMA case registry. McIlvainea 2006;16:47–68. https://fungimag.com/archives/Poisonings.pdf
4. Pfab R, Haberl B, Kleber J, Zilker T. Cerebellar effects after consumption of edible morels (*Morchella conica*, *Morchella esculenta*). Clin Toxicol (Phila) 2008;46:259–60. PMID:18344109 https://doi.org/10.1080/15563650701206715
5. Saviuc P, Harry P, Pulce C, Garnier R, Cochet A. Can morels (*Morchella sp.*) induce a toxic neurological syndrome? Clin Toxicol (Phila) 2010;48:365–72. PMID:20507248 https://doi.org/10.3109/15563651003698034
6. Piqueras J. Morel mushroom toxicity: an update. Fungi 2021;14:42–52. https://www.fungimag.com/spring-2021-articles/Morel%20Toxicity%20Update.pdf

Notes from the Field

Surveillance for Multisystem Inflammatory Syndrome in Children — United States, 2023

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Multisystem inflammatory syndrome in children (MIS-C) is a rare but serious condition typically occurring 2–6 weeks after SARS-CoV-2 infection and characterized by fever and multiorgan involvement (*1*,*2*). In May 2020, CDC created an MIS-C case definition and established a passive national surveillance system for voluntary case reporting by state and local health departments.* In 2022, CDC and the Council of State and Territorial Epidemiologists (CSTE) created a new surveillance case definition that went into effect on January 1, 2023† (*3*). Approximately 87% of cases reported using the 2020 case definition also meet the 2023 case definition. This report describes 2023 MIS-C cases and compares them with cases reported earlier in the COVID-19 pandemic.

Investigation and Outcomes

All MIS-C cases reported to CDC national surveillance as of February 26, 2024, with illness onset during 2023 were included, and patient characteristics were analyzed. Incidence (cases per 1,000,000 person-months) was estimated using bridged-race 2020 population estimates from U.S. Census Bureau data (*4*). COVID-19 vaccination status was reported for children who were age-eligible for vaccination§ at the time of MIS-C illness onset. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.¶

Among 117 MIS-C patients with illness onset in 2023, 31 (26%) had onset during August–October, after an increase in COVID-19 activity earlier in the summer; this finding represented a two-thirds increase in case counts compared with the 19 (16%) cases reported with onset during the preceding 3 months.** Overall MIS-C incidence in 2023 was 0.11 cases per million person-months (95% CI = 0.10–0.14), representing an 80% decline in incidence compared with that during April–December 2022 (0.56 cases per million person-months; 95% CI = 0.51–0.62), and a 98% decrease from the peak of 6.79 (95% CI = 6.56–7.03) early in the COVID-19 pandemic (October 2020–April 2021).††

The median age of MIS-C patients with illness onset in 2023 was 7 years (Table), whereas the median age during February 2020–January 2022 was 9 years, and during April–December 2022 was 5 years§§ (*1*,*2*). A similar decline in MIS-C incidence and shift to a younger age group in 2022 was reported in England (*5*).

Among the 117 MIS-C patients with illness onset in 2023, 68 (58%) had no underlying medical conditions; 58 (50%) required intensive care unit (ICU)-level care, 40 (34%) experienced shock, and 31 (27%) experienced cardiac dysfunction. These prevalences are similar to published national MIS-C surveillance data for 2,116 cases reported during July 9, 2021–January 31, 2022 (52% requiring ICU-level care, 38% with shock, and 29% with cardiac dysfunction), and are improved compared with data for cases reported for the total 4,470 cases during the earliest part of the pandemic, from February 19, 2020–July 31, 2021 (63% requiring ICU-level care, 45% with shock, and 31% with cardiac dysfunction) (*1*,*2*).

* https://www.cdc.gov/mis/index.html

† The 2023 CSTE/CDC MIS-C case definition differs from the 2020 CDC case definition in the following conditions: 1) no requirement for duration of fever; 2) a C-reactive protein test result of 3.0 mg/dL is required to indicate systemic inflammation; 3) respiratory, renal, and neurologic systems are excluded from organ involvement criteria; 4) shock is added as a separate organ system manifestation; and 5) SARS-CoV-2 testing now includes time parameters (i.e., SARS-CoV-2 viral testing within 60 days of MIS-C hospitalization or serology test during MIS-C illness).

§ For this analysis, 8 months was considered the minimum age by which a child could plausibly have completed an mRNA primary vaccination series, with 6 months being the earliest possible age at first dose, and ≤4 weeks from first dose required to complete the 2-dose primary series, and 28 days between time since last dose and hospitalization.

¶ 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.

** https://covid.cdc.gov/covid-data-tracker/#mis-national-surveillance (Accessed March 11, 2024).

†† SARS-CoV-2 surveillance data were used to define variant-predominant periods, allowing for 2 weeks to MIS-C onset from when a variant exceeded 50% circulating lineages. Variant-predominant period (dates), number of MIS-C cases, and incidence (cases per 1,000,000 person-months with 95% CI) were defined as follows: pre-Delta (October 15, 2020–April 5, 2021): n = 3,284, incidence = 6.79; 95% CI = 6.56–7.03; Delta (July 10–December 24, 2021): n = 2,300, incidence = 4.90; 95% CI = 4.70–5.10; Omicron BA.1/BA 1.1 (January 1–April 8, 2022): n = 1,149, incidence = 4.21; 95% CI = 3.98–4.46; Omicron BA.2/BA.4/BA.5 (April 9–December 31, 2022): n = 422, incidence = 0.56; 95% CI = 0.51–0.62; and 2023 Omicron subvariants (January 1–December 31, 2023): n = 117, incidence = 0.11; 95% CI = 0.10–0.14.

§§ SARS-CoV-2 surveillance data were used to define variant-predominant periods, allowing for 2 weeks to MIS-C onset from when a variant exceeded 50% circulating lineages. Variant-predominant period (dates) and median age (with IQR) were defined as follows: pre-Delta (October 15, 2020–April 5, 2021): median age = 9.2 years, IQR = 5.4–13.1 years; Delta (July 10–December 24, 2021): median age = 9.1 years, IQR = 5.5–12.3 years; Omicron BA.1/BA 1.1 (January 1–April 8, 2022): median age = 7.5 years, IQR = 4.1–11.5 years; Omicron BA.2/BA.4/BA.5 (April 9–December 31, 2022): median age = 5.4 years, IQR = 2.8–9.8 years; and 2023 Omicron subvariants (January 1–December 31, 2023): median age = 6.9 years; IQR = 3.4–11.5 years.

TABLE. Characteristics of patients with multisystem inflammatory syndrome in children reported to CDC (N = 117)* — United States, 2023

Characteristic	No. (%)
Age, yrs, median (IQR)	6.9 (3.4–11.5)
Age group, yrs	
<1	8 (6.8)
1–4	34 (29.1)
5–11	50 (42.7)
12–15	17 (14.5)
16–20	8 (6.8)
Male sex	72 (61.5)
Race and ethnicity†	
Asian, non-Hispanic	8 (6.8)
Black or African American, non-Hispanic	30 (25.6)
White, non-Hispanic	40 (34.2)
Hispanic or Latino	27 (23.1)
Other race§	7 (6.0)
U.S. Census Bureau region	
Northeast	11 (9.4)
Midwest	25 (21.4)
South	55 (47.0)
West	26 (22.2)
Underlying medical conditions¶	
None	68 (58.1)
Obesity	32 (27.4)
Chronic lung disease (including asthma)	16 (13.7)
Neurologic or neuromuscular or developmental condition	9 (7.7)
Cardiovascular condition	6 (5.1)
Immunosuppressive disorder or malignancy	2 (1.7)
SARS-CoV-2 testing	
Positive antibody test result (among 93 patients tested by serology)	88 (94.6)
Positive PCR or antigen test result (among 88 patients tested by PCR or antigen)	27 (30.7)
Organ system involvement	
Cardiac,††	**63 (53.8)**
Elevated troponin	45 (38.5)
Cardiac dysfunction (left or right)	31 (26.5)
Left ventricular ejection fraction <55%	21 (17.9)
Coronary artery dilatation, ectasia, or aneurysm	22 (18.8)
Pericardial effusion or pericarditis	14 (12.0)
Myocarditis	13 (11.1)
Congestive heart failure	2 (1.7)
Shock,§§	**40 (34.2)**
Hematologic,¶¶	**63 (53.8)**
Thrombocytopenia (platelets <150,000 cells/μL)	37 (31.6)
Lymphopenia (ALC <1000 cells/μL)	34 (29.1)
Gastrointestinal,***	**104 (88.9)**
Other abdominal involvement†††	12 (10.3)
Mesenteric adenitis	3 (2.6)
Appendicitis or inflamed appendix	2 (1.7)
Cholecystitis or inflamed gallbladder	1 (0.9)
Mucocutaneous,§§§	**104 (88.9)**
Other symptoms or complications reported	
Cough	44 (37.6)
Neck pain	26 (22.2)
Shortness of breath	23 (19.7)
Encephalopathy	4 (3.4)
Meningitis or encephalitis	1 (0.9)
Treatment	
Intravenous immunoglobulin	100 (85.5)
Steroids	94 (80.3)
Hospital course and outcomes	
Oxygen, high flow nasal cannula	20 (17.1)
Invasive mechanical ventilation	13 (11.1)
CPAP or BiPAP	4 (3.4)
Extracorporeal membrane oxygenation	2 (1.7)
No. of days in hospital, median (IQR)	4 (3–7)
ICU-level care¶¶¶	58 (49.6)
Death	3 (2.6)
Reported COVID-19 vaccination status (among 112 age-eligible** patients)**	
No vaccination	92 (82.1)
Vaccination (any dose) received	20 (17.9)
1 dose received††††	4 (3.6)
2 doses received	11 (9.8)
≥3 doses received	5 (4.5)
>12 mos from last vaccine dose to MIS-C onset (among 20 vaccinated patients)	12 (60.0)
Time from most recent vaccine dose to MIS-C onset, no. of days, median (IQR)	401 (247–511)

Abbreviations: ALC = absolute lymphocyte count; BiPAP = bilevel positive airway pressure; CPAP = continuous positive airway pressure; CSTE = Council of State and Territorial Epidemiologists; ICU = intensive care unit; MIS-C = multisystem inflammatory syndrome in children; PCR = polymerase chain reaction.

* https://www.cdc.gov/mis/index.html

† Five patients were reported as race or ethnicity unknown or refused to answer.

§ Patients defined as Other race were those who identified as non-Hispanic multiple race (one), Native Hawaiian or other Pacific Islander (two), or non-Hispanic other (four).

¶ No children with diabetes mellitus or sickle cell disease were reported; obesity was ascertained by clinician diagnosis of obesity or body mass index–based obesity (calculated only in children aged >2 years).

** Per 2023 CSTE/CDC MIS-C surveillance case definition. https://www.cdc.gov/mis/mis-c/hcp_cstecdc/index.html

†† Cardiac involvement indicated by left ventricular ejection fraction <55%; coronary artery dilatation, aneurysm, or ectasia; or troponin elevated above normal laboratory range, or indicated as elevated in a clinical note.

§§ Shock indicated in a clinical note or receipt of vasopressors.

¶¶ Platelet count <150,000 cells/μL or ALC <1,000 cells/μL.

*** Abdominal pain, vomiting, or diarrhea.

††† Other abdominal involvement was defined as having colitis or enteritis, hepatomegaly or splenomegaly, liver failure, intussusception, or free fluid.

§§§ Rash, inflammation of the oral mucosa, conjunctivitis or conjunctival injection, or extremity findings (erythema [redness] or edema [swelling] of the hands or feet).

¶¶¶ ICU-level care was defined as having a documented ICU admission or having received ICU-level care including mechanical ventilation, vasopressor support, or extracorporeal membranous oxygenation.

**** A total of 112 patients were age-eligible for vaccination at the time of illness onset. Eight months was considered the minimum age at which a child could plausibly have received 2 doses of a primary mRNA vaccination series, with 6 months being the earliest possible age at first dose and ≤4 weeks from first dose required to complete a 2-dose primary series, and 28 days between time since last dose and hospitalization.

†††† One age-eligible patient was reported to have received 2 COVID-19 vaccine doses; however, the second dose was received <14 days before onset of MIS-C; therefore, the child was categorized as having received only 1 dose before illness onset.

Summary

What is already known about this topic?

Multisystem inflammatory syndrome in children (MIS-C) is a rare but serious condition typically occurring 2–6 weeks after SARS-CoV-2 infection and characterized by fever and multiorgan involvement.

What is added by this report?

MIS-C incidence has decreased from early in the COVID-19 pandemic (highest in late 2020–early 2021), but cases continue to occur with a recent relative increase in the fall of 2023 after a period of increased COVID-19 activity in the general population. Among 117 patients with MIS-C in 2023, approximately one half required intensive care unit–level care. More than 80% (92 of 112) of MIS-C cases were in vaccine-eligible but unvaccinated children, and among the 20 vaccinated children, 60% likely had waned immunity at the time of MIS-C illness.

What are the implications for public health practice?

MIS-C cases continue to occur but at low rates, making ongoing surveillance valuable. COVID-19 vaccination remains important for preventing MIS-C.

Three (3%) patients with MIS-C died in 2023. Although 112 (96%) patients were age-eligible for COVID-19 vaccination, only 20 (18%) had documented receipt of any COVID-19 vaccine. Among the 48 vaccine-eligible patients with underlying medical conditions, nine (19%) had documented receipt of any COVID-19 vaccine. Among the 20 patients who had received COVID-19 vaccination, 12 (60%) received their last dose >12 months before MIS-C onset.

Conclusions and Recommendations

MIS-C continues to occur, but at low rates compared with those observed early in the COVID-19 pandemic. MIS-C incidence has declined, a recent shift to cases in younger children has occurred, and clinical characteristics have evolved. The reported 2023 incidence is likely an underestimate because jurisdictional reporting of MIS-C cases with illness onset in 2023 is incomplete, and case counts and incidence might also be affected by the change in case definition that occurred that year. Changes might also reflect changing SARS-CoV-2 population immunity from vaccination and previous infection, and characteristics of the predominant circulating SARS-CoV-2 variants. Clinicians should recognize that MIS-C might occur, especially during and after periods of increased COVID-19 activity, and should be familiar with treatment guidelines.[¶¶] Continued reporting of MIS-C cases to jurisdictional health departments is important to monitor trends and patients' demographic and clinical characteristics. MIS-C patients with illness onset in 2023 were predominantly unvaccinated children and those whose vaccine-induced immunity had likely waned. COVID-19 vaccination remains an important tool for preventing MIS-C. CDC recommends that all children aged ≥6 months stay up to date with COVID-19 vaccination to protect against serious COVID-19 illness and complications, including MIS-C.

[¶¶] https://www.covid19treatmentguidelines.nih.gov/management/clinical-management-of-children/hospitalized-children-therapeutic-management-of-mis-c/

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References

1. Miller AD, Zambrano LD, Yousaf AR, et al.; MIS-C Surveillance Authorship Group. Multisystem inflammatory syndrome in children—United States, February 2020–July 2021. Clin Infect Dis 2022;75:e1165–75. PMID:34864955 https://doi.org/10.1093/cid/ciab1007
2. Miller AD, Yousaf AR, Bornstein E, et al. Multisystem inflammatory syndrome in children during severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) Delta and Omicron variant circulation—United States, July 2021–January 2022. Clin Infect Dis 2022;75(Suppl 2):S303–7. PMID:35684958 https://doi.org/10.1093/cid/ciac471
3. Melgar M, Lee EH, Miller AD, et al. Council of State and Territorial Epidemiologists/CDC surveillance case definition for multisystem inflammatory syndrome in children associated with SARS-CoV-2 infection—United States. MMWR Recomm Rep 2022;71(No. RR-4):1–14. PMID:36520808 https://doi.org/10.15585/mmwr.rr7104a1
4. CDC. Bridged-race population estimates 1990–2020 request. Atlanta, GA: US Department of Health and Human Services, CDC; 2020.https://wonder.cdc.gov/bridged-race-v2020.html
5. Shingleton J, Williams H, Oligbu G, et al. The changing epidemiology of PIMS-TS across COVID-19 waves: prospective national surveillance, January 2021 to July 2022, England. J Infect 2022;85:702–69. PMID:36273638 https://doi.org/10.1016/j.jinf.2022.10.017

Notes from the Field

Measles Outbreak — Cook County, Illinois, October–November 2023

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On October 10, 2023, the Cook County Department of Public Health (CCDPH) in Illinois was notified by hospital A, a large pediatric facility, of a suspected measles case in a child aged 2 years (patient A) who had immigrated from Yemen on September 29 and who had no history of receipt of measles, mumps, and rubella (MMR) vaccine. The child visited hospital A's emergency department (ED) on October 5 with fever, cough, and coryza and, after receipt of negative COVID-19, influenza, and respiratory syncytial virus test results, received a diagnosis of an unspecified viral illness. On October 8, the child visited hospital B's ED with worsening respiratory symptoms and received a positive rhinovirus/enterovirus test result on a respiratory pathogen panel, after which the child was transferred to hospital A and admitted for respiratory distress related to bronchiolitis and underlying reactive airway disease. The next day, while hospitalized, the child developed a maculopapular rash. On October 10, the child's family reported contact with a person with clinically diagnosed measles before U.S. arrival.* Measles was confirmed by real-time reverse transcription–polymerase chain reaction (RT-PCR) testing on October 11; the child was discharged the same day.

Investigation and Outcomes

During the child's October 5–11 health care encounters, 247 health care workers† and 177 patients and patient companions§ were considered to have been exposed, including 13 children aged <1 year, five immunosuppressed children, and one child aged >1 year with no history of MMR vaccination. Among these 19 children, two received a dose of MMR vaccine within 72 hours of the exposure, and 13 received immune globulin.

The index patient's household contacts included two siblings with no history of MMR vaccination and with serologic testing indicating measles susceptibility. One sibling, aged 4 years, (patient B) arrived in the United States at the same time as the index patient (September 29). The second sibling, aged 9 years, (patient C) had arrived in the United States in January 2023. Both siblings developed measles while in quarantine with rash onsets on October 22 (patient B) and November 1 (patient C). Patient B also reported fever, cough, coryza, and conjunctivitis; patient C also reported fever. Neither child was hospitalized, although patient B required an ED visit at hospital A for supportive care. On October 17, exposure notification letters were delivered to all residents in the apartment building where the index patient lived.

On October 30, hospital A notified CCDPH of another child, aged 2 years, (patient D) who had been evaluated in an ED early that morning with fever, cough, and coryza, then discharged. The family of that child lived in the same 2-story apartment building as the index patient, but on a different floor. Patient D had no history of MMR vaccine; the child's parents reported objections to MMR vaccine based on personal beliefs and perceptions about vaccine side effects. Measles was confirmed in this child by RT-PCR testing on October 30; rash onset occurred on November 1. The families of patients A–C and patient D had different cultural backgrounds from one another and spoke different primary languages; both families independently reported no contact with the other family. Their apartment units did not have shared ventilation; however, laundry facilities and building entrances were shared.

On October 31, testing was also performed for a sibling of patient D, a child aged 1 year (patient E), also with no history of MMR vaccine, who had isolated coryza and who attended a child care facility¶ on October 30 while symptomatic; a nasopharyngeal swab collected in the home confirmed measles by RT-PCR testing. Attendees and staff members of the child care facility were notified the same day. One child aged 2 months received immune globulin, one child aged 11 months received

* The patient with clinically diagnosed measles was an extended family member of a similar age as the index patient. The exposure occurred in Yemen on September 24 or 25.

† All health care workers had either received 2 doses of MMR vaccine or had titers documenting immunity. One health care worker who had received 3 MMR vaccine doses was considered susceptible based on titer results; this worker was excluded from work and monitored for 21 days, during which time measles did not develop.

§ Immunity status was verified for 174 exposed patients and patient companions; three patients were lost to follow-up. Among the 174 patients with available information, 105 (60%) had documented proof of immunity (including two patients who received MMR vaccine within 72 hours of exposure). The remaining 69 (40%) persons were offered postexposure prophylaxis, if eligible; advised to quarantine (not attend work, school, or a child care facility); and were monitored for 21 days. None developed measles.

¶ Illinois state law mandates age-appropriate MMR vaccination for children attending schools and child care facilities; however, families with religious objections can obtain an exemption. None of the children in the family of the index patient were attending school or a child care facility at the time of the investigation. The director of the child care facility attended by patients D and E reported that a religious exemption form had been submitted for both unvaccinated children; however, despite multiple requests from CCDPH, copies of these forms were not provided.

1 dose of MMR vaccine, and 11 children who had received their first MMR vaccine dose received an early second dose as post-exposure prophylaxis.** Fever in patient E did not occur until November 6, and rash did not appear until November 9, which was 9 days after the positive RT-PCR test result and child care facility notification.†† Measles testing is indicated for susceptible contacts of measles cases when the contact has prodromal symptoms (i.e., fever, cough, coryza, or conjunctivitis); however, isolated coryza experienced by this patient at the time of specimen collection might not have been related to measles. Because testing for measles before fever onset is not typically performed, an accurate infectious period for this patient was difficult to ascertain. Patient E's symptoms resolved without requiring emergency care or hospitalization. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.§§

Preliminary Conclusions and Actions

In this community outbreak, five children developed measles. Although all patients were eligible to have received MMR vaccine before their exposures, none had been vaccinated because of cultural barriers, limited access to care, and vaccine refusal. Whereas previous measles outbreaks in the United States have primarily occurred in underimmunized communities with highly interconnected social networks (*1*), neither of the affected families described in this report was part of a similar close-knit social community, and vaccination coverage data for the patients' sociocultural groups were not available. Public health responses have typically required tailored approaches that include developing culturally appropriate education materials, securing translation services, and building relationships with community leaders (*2*). These efforts are time-consuming and costly, with a median cost per measles patient of approximately $33,000 during 2004–2017 (*3*). This outbreak is a reminder that measles is highly contagious, and transmission can occur between children who are not social contacts. Outbreaks might become more common as global measles cases continue to rise (*4*) and the number of children with exemptions to childhood vaccines increases (*5*). Clinicians should consider measles in susceptible patients with febrile rash illness and clinically compatible measles symptoms. All eligible children and susceptible adults should receive 2 appropriately spaced doses of MMR vaccine to prevent measles and measles outbreaks.¶¶

** MMR vaccine was administered within 72 hours after exposure; immune globulin was administered within 6 days after exposure.

†† Measles patients are typically considered infectious from 4 days before through 4 days after rash onset.

§§ 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.

¶¶ https://www.cdc.gov/vaccines/vpd/mmr/public/

Summary

What is already known about this topic?

Measles is a highly contagious vaccine-preventable disease. In the United States, 2 doses of measles, mumps, and rubella (MMR) vaccine are recommended for all children aged 12–15 months and 4–6 years.

What is added by this report?

During October 5–November 1, 2023, five measles cases occurred in unvaccinated, vaccine-eligible children aged 1–9 years who lived in the same apartment building but did not socialize with one another. During the outbreak, approximately 400 persons were exposed to measles, including 13 children aged <1 year.

What are the implications for public health practice?

Two doses of appropriately spaced MMR vaccine are recommended for all children and other susceptible persons to prevent measles cases and outbreaks.

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References

1. 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
2. Hall V, Banerjee E, Kenyon C, et al. Measles outbreak—Minnesota April–May 2017. MMWR Morb Mortal Wkly Rep 2017;66:713–7. PMID:28704350 https://doi.org/10.15585/mmwr.mm6627a1
3. Pike J, Leidner AJ, Gastañaduy PA. A review of measles outbreak cost estimates from the United States in the postelimination era (2004–2017): estimates by perspective and cost type. Clin Infect Dis 2020;71:1568–76. PMID:31967305 https://doi.org/10.1093/cid/ciaa070
4. Minta AA, Ferrari M, Antoni S, et al. Progress toward measles elimination—worldwide, 2000–2022. MMWR Morb Mortal Wkly Rep 2023;72:1262–8. PMID:37971951 https://doi.org/10.15585/mmwr.mm7246a3
5. Seither R, Yusuf OB, Dramann D, Calhoun K, Mugerwa-Kasujja A, Knighton CL. Coverage with selected vaccines and exemption from school vaccine requirements among children in kindergarten—United States, 2022–23 school year. MMWR Morb Mortal Wkly Rep 2023;72:1217–24. PMID:37943705 https://doi.org/10.15585/mmwr.mm7245a2

Erratum

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The report, "Reduced Odds of Mpox-Associated Hospitalization Among Persons Who Received JYNNEOS Vaccine — California, May 2022–May 2023" contained several errors.

On page 994, in Table 1, the total number of unvaccinated mpox cases should have read **n = 3,845.** Under the Gender identity characteristic, the p-value for the Female category should have read **0.122**, the p-value for the Genderqueer or non-binary category should have read **0.107**, the p-value for the Male category should have read **0.021**, the p-value for the Transgender female category should have read **0.058**, and the p-value for the Declined to answer category should have read **<0.001**. Under the Race and ethnicity characteristic, the p-value for the AI/AN category should have read **0.272**, the p-value for the Asian category should have read **0.644**, the p-value for the Black or African American category should have read **0.002**, the p-value for the NH/OPI category should have read **0.451**, and the p-value for the Multiple races category should have read **0.003**. Under the Sexual orientation characteristic, the p-value for the Declined to answer category should have read **0.009**, and the p-value for the Orientation not listed category should have read **0.057**.

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