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Invasive Nontypeable *Haemophilus influenzae* Disease Outbreak at an Elementary School — Michigan, May 2023

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Abstract

In May 2023, the Detroit Health Department was notified of four cases of invasive nontypeable *Haemophilus influenzae* (Hi) disease among students attending the same elementary school and grade, all with illness onsets within 7 days. Three patients were hospitalized, and one died. Most U.S. cases of invasive Hi disease are caused by nontypeable strains. No vaccines against nontypeable or non–type b Hi strains are currently available. Chemoprophylaxis is not typically recommended in response to nontypeable Hi cases; however, because of the high attack rate (four cases among 46 students; 8.7%), rifampin prophylaxis was recommended for household contacts of patients with confirmed cases and for all students and staff members in the school wing where confirmed cases occurred. Only 10.8% of students for whom chemoprophylaxis was recommended took it, highlighting gaps in understanding among caregivers and health care providers about persons for whom chemoprophylaxis was recommended. Public health authorities subsequently enhanced communication and education to the school community, improved coordination with health care partners, and established mass prophylaxis clinics at the school. This outbreak highlights the potential for nontypeable Hi to cause serious illness and outbreaks and the need for chemoprophylaxis guidance for nontypeable Hi disease. Achieving high chemoprophylaxis coverage requires education, communication, and coordination with community and health care partners.

Introduction

After the introduction and widespread use of vaccines against *Haemophilus influenzae* (Hi) type b (Hib) in the United States for the last 30 years, the incidence of invasive Hi disease among children aged <5 years declined by >99%. Invasive Hi is now most commonly caused by nontypeable strains, which are not covered by Hib vaccines (*1*). Nontypeable Hi lacks a polysaccharide capsule and has been associated with noninvasive infections (e.g., otitis media and bronchitis) but is capable of causing invasive disease (*1*). Invasive Hi disease incidence is highest among infants and older adults; however, outbreaks are rare (*1*). Four cases of nontypeable Hi disease were reported among children aged 5–6 years who attended the same elementary school for kindergarten in Detroit, Michigan; one child died, and three others were hospitalized. Chemoprophylaxis was recommended for household contacts of the patients and for students and staff members who worked or attended class in the same school wing where the cases had occurred. The

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Detroit Health Department (DHD), in collaboration with the Michigan Department of Health and Human Services (MDHHS) and CDC, investigated the outbreak to prevent additional illnesses and assessed barriers to obtaining and taking recommended chemoprophylaxis. This activity was considered routine public health surveillance and outbreak response by MDHHS and, therefore, did not require human subjects review. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.*

Investigation and Results

Identification of Outbreak

On May 1, 2023, DHD was notified of a case of invasive Hi disease in a child who died suddenly. By May 8, three additional invasive Hi disease cases were identified among students in the same school and grade, including two children from the same classroom as the index patient.

Patient Characteristics

The four cases occurred among children aged 5–6 years; all were non-Hispanic Black or African American boys. All patients had symptom onset within 7 days of each other; signs and symptoms began suddenly or worsened rapidly and included fever (four patients), myalgia (four), lethargy (four), headache (four), vomiting (two), and sore throat (two) (Table 1). None of the patients had a chronic medical condition that increases the risk for acquiring invasive Hi disease. Three patients (patients A, C, and D), including the index patient (patient A), were co-infected with at least one respiratory virus. Respiratory viruses can modulate the host immune response, and preceding respiratory infections have been associated with invasive Hi disease (*2*). The index patient died before hospitalization; the other three patients were hospitalized and recovered fully with antibiotic treatment. Using the Council of State and Territorial Epidemiologists' surveillance case definition for invasive Hi disease (*3*), the four cases were confirmed by isolation of Hi from a normally sterile site. Hi was cultured from blood (three patients) and cerebrospinal fluid (one; specimen collected 27 hours postmortem). Group A *Streptococcus* was isolated from the index patient's postmortem blood specimen.

Hi Isolate Characteristics

Whole genome sequencing (WGS) was conducted by MDHHS Bureau of Laboratories. The four Hi isolates were nontypeable (unencapsulated) and shared the same sequence type (ST-1714) with zero single nucleotide polymorphism (SNP) differences (with highly recombinant sites omitted from analysis). Additional WGS analysis conducted by CDC after the outbreak investigation found that the four isolates were within 13–39 SNPs of several isolates from an ST-1714 cluster reported in Georgia (*4*).

* 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.

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TABLE 1. Clinical and laboratory characteristics of four pediatric* patients with invasive nontypeable *Haemophilus influenzae* disease — Detroit, Michigan, 2023

Patient	Signs and symptoms	Clinical encounter type	Outcome	Cerebrospinal fluid culture results	Blood culture results	Hi sequence type	Respiratory viruses detected by nucleic acid amplification
A	Fever, myalgia, lethargy, headache, sore throat, cough, rhinorrhea, abdominal pain, and difficulty breathing	Outpatient	Died	Hi†	GAS†	ST-1714	Adenovirus, RSV, coronavirus HKU1, coronavirus NL63, and RV/EV†,§
B	Fever, myalgia, lethargy, headache, vomiting, and sore throat	Inpatient	Survived	NP	Hi	ST-1714	None detected¶
C	Fever, myalgia, lethargy, headache, vomiting, rhinorrhea, and rash	Inpatient	Survived	NP	Hi	ST-1714	Adenovirus and SARS-CoV-2
D	Fever, myalgia, lethargy, headache, diarrhea, and cough	Inpatient	Survived	NP	Hi	ST-1714	RV/EV§

Abbreviations: GAS = group A streptococcus; Hi = nontypeable *Haemophilus influenzae*; NP = not performed; RSV = respiratory syncytial virus; RV/EV = rhinovirus/enterovirus.
* All patients were aged 5–6 years and attended the same elementary school and grade.
† Specimens were collected 27 hours postmortem.
§ Assay does not differentiate between rhinovirus and enterovirus.
¶ Influenza A, influenza B, RSV, and SARS-CoV-2 were tested for and not detected. Testing for additional pathogens was not performed.

Public Health Response

Routine Student Illness Surveillance

In the days immediately after the death of the index patient, school officials reported a substantial increase in reports of ill students and concerned families and staff members. Other schools within the district reported an increase in student absenteeism for unidentified illnesses, initially making it difficult to assess the scope of the outbreak.

Enhanced Illness Surveillance

To supplement routine surveillance and identify additional potential Hi disease cases, DHD requested that school administrators throughout the district notify public health officials of all cases of reportable communicable diseases or illnesses and encourage symptomatic students and staff members to seek health care. A health alert was distributed to health care providers to inform them of the outbreak and to recommend testing for Hi and other circulating pathogens for patients with clinically compatible illnesses. Through the enhanced school surveillance, public health authorities were notified of 126 ill persons from 38 schools (including 42 persons from the affected school). Attempts were made to contact all ill persons to administer a standardized questionnaire about signs and symptoms, risk factors, and potential epidemiologic links to other cases. One of the four detected cases was reported via this surveillance: patient D had recently been discharged from an emergency department with a viral syndrome diagnosis, and DHD strongly encouraged the family to seek medical attention again because the patient's health was not improving. The patient was admitted to a local hospital, and Hi bacteremia was confirmed through blood culture. All four cases were reported via routine laboratory and provider-based public health surveillance.

Chemoprophylaxis Recommendations

Recommendations for chemoprophylaxis to prevent Hi disease cases are typically limited to close contacts of patients with Hib† disease and, sometimes, Hi type a (Hia) disease (*5*,*6*). In this outbreak, however, based on the unusually high attack rate (four cases among 46 students; 8.7%) and that the four cases occurred among students from both of the school's two kindergarten classrooms, DHD recommended chemoprophylaxis after the third case was reported. Rifampin was recommended for all household contacts of patients with invasive Hi disease (i.e., 13 contacts of three patients; the number of household contacts for one patient was unknown) and for all 186 students and an unknown number of staff members in the wing of the school where the confirmed cases occurred. In a letter and a virtual meeting, school administrators and DHD updated the school community about the outbreak, explained the rationale for chemoprophylaxis, and advised eligible persons to seek prophylaxis from their primary care provider or the school health center if they did not have a provider.

Chemoprophylaxis Coverage and Barriers

DHD and MDHHS contacted caregivers of patients and eligible students to determine whether rifampin prophylaxis

† For cases of invasive Hib disease, and sometimes Hia, rifampin chemoprophylaxis is recommended for all household contacts in households with members aged <4 years who are not fully vaccinated or members aged <18 years who are immunocompromised, regardless of their vaccination status. Chemoprophylaxis is recommended in child care facility settings when two or more cases of invasive Hib disease have occurred within 60 days of one another and unimmunized or underimmunized children attend the facility.

was initiated. Among the four households with cases, one household completed chemoprophylaxis, one preferred to discuss chemoprophylaxis with their primary care provider, one experienced difficulty obtaining the prescription, and one declined chemoprophylaxis. Among 186 eligible students, the caregivers of 102 (54.8%) were interviewed; 11 (10.8%) students were reported to have started or completed chemoprophylaxis within 18 days after chemoprophylaxis was recommended to them. An additional 19 (18.6%) caregivers expressed interest in chemoprophylaxis but had not obtained the prescription or the antibiotic by the time of interview. Among the 91 students who had not started or completed chemoprophylaxis at the time of interview, reasons provided by caregivers for not taking chemoprophylaxis included not being aware of the recommendation (nine; 9.9%), not having time to obtain the chemoprophylaxis (nine; 9.9%), waiting for an appointment with their primary care provider (nine; 9.9%), thinking it was unnecessary because their child was not symptomatic or they did not want their child to take antibiotics (eight; 8.8%), and needing more information or being undecided (eight; 8.8%) (Table 2).

In response to identified barriers, the school distributed additional educational materials highlighting the importance of chemoprophylaxis, and DHD collaborated with health care partners to establish clinics within the school, including clinics that operated during nonbusiness hours. DHD also received reports of health care providers incorrectly counseling families that chemoprophylaxis was unnecessary and that children were protected by Hib vaccine,[§] highlighting misunderstandings among caregivers and providers and prompting DHD to send a second health alert to the health care community. No additional cases were reported for the remainder of the school year.

TABLE 2. Reasons* for not initiating chemoprophylaxis reported by interviewed caregivers of children who were recommended to receive chemoprophylaxis because of potential exposure to nontypeable *Haemophilus influenzae*† (N = 91) — Detroit, Michigan, 2023

Reason	No. (%)
Interested but had not obtained by the time of interview	19 (21)
Not aware of chemoprophylaxis recommendation	9 (10)
Did not have time to obtain chemoprophylaxis	9 (10)
Waiting for appointment with primary care provider	9 (10)
Did not think it was necessary or did not want child taking antibiotics	8 (9)
Needed more information or undecided	8 (9)
Primary care provider advised against or said not necessary	5 (6)
Did not have primary care provider	4 (4)
Difficulty obtaining chemoprophylaxis	4 (4)
Needed transportation assistance	3 (3)
Wanted to talk with primary care provider about chemoprophylaxis	3 (3)
Did not know where to obtain chemoprophylaxis	1 (1)
Reason not provided	32 (35)

* Some caregivers mentioned multiple reasons.
† Interviews occurred 5–18 days after chemoprophylaxis was recommended.

Discussion

Nontypeable Hi is currently the most common cause of invasive Hi disease in the United States; however, secondary transmission is uncommon, and outbreaks are rare (*1*). Hib vaccines do not provide protection against nontypeable Hi, and no vaccines against nontypeable strains are currently available. This invasive Hi disease outbreak at an elementary school highlights the potential for nontypeable Hi to cause secondary cases (*7*) and severe disease outside the typical highest-risk age groups (i.e., <1 year and ≥65 years). Co-infection with respiratory viruses (*2*), decreased exposure to Hi because of COVID-19 nonpharmaceutical interventions and subsequent decreased mucosal immunity (*8*), or strain characteristics might have contributed to the high secondary attack rate.

This outbreak also highlights the need for guidance concerning chemoprophylaxis for nontypeable Hi disease. Although the actual chemoprophylaxis coverage during this outbreak is unknown, only 11% of those interviewed reported taking chemoprophylaxis. This finding might be an underestimate because it does not include students who might have started chemoprophylaxis after the interview. In addition, this finding might not be representative of all persons who were recommended to take prophylaxis because the caregivers of 84 (45.2%) of the 186 students who were advised to take prophylaxis did not respond to public health outreach, and school staff members for whom prophylaxis was recommended were not interviewed because public health resources were limited. During interviews, caregivers reported interest in chemoprophylaxis but described multiple difficulties in obtaining it, highlighting accessibility challenges and gaps in health care provider awareness about the outbreak and understanding of the importance of chemoprophylaxis for nontypeable Hi disease. Community trust in the medical establishment was not assessed, so its contribution to low chemoprophylaxis coverage could not be evaluated. Coverage might have been improved had conveniently located mass prophylaxis clinics been rapidly established, and communication with the school community and health care providers been better coordinated.

The epidemiology of ST-1714 has not been characterized nationally. Although the outbreak isolates are closely related to an ST-1714 clonal strain reported among adults in Atlanta, Georgia, epidemiologic differences are notable: the Georgia cluster primarily occurred among adult men living with HIV, with septic arthritis as an unusually common presentation (*4*).

[§] Hib vaccine is not protective against nontypeable Hi.

Summary

What is already known about this topic?

Most U.S. cases of invasive *Haemophilus influenzae* (Hi) disease are caused by nontypeable strains. No vaccines against nontypeable or non–type b Hi strains are currently available.

What is added by this report?

Four invasive nontypeable Hi disease cases occurred among young children in an elementary school in Detroit, Michigan. Three patients were hospitalized, and one died. Chemoprophylaxis was recommended for the patients' household contacts and for students and staff members in the school wing where cases occurred. Only 11% of students for whom chemoprophylaxis was recommended took it; misinformation among caregivers and health care providers and difficulty obtaining chemoprophylaxis contributed to low coverage.

What are the implications for public health practice?

Nontypeable Hi can cause outbreaks among young children; therefore, chemoprophylaxis guidance is needed. Achieving high chemoprophylaxis coverage requires education, communication, and coordination with community and health care partners.

Implications for Public Health Practice

Nontypeable Hi can cause serious illness and outbreaks among young children; therefore, chemoprophylaxis guidance for nontypeable Hi disease is needed. Achieving high chemoprophylaxis coverage requires education, communication, and coordination with community and health care partners. Expanded WGS of nontypeable Hi isolates is needed to better understand the epidemiology of ST-1714 nationally and to detect future clusters and outbreaks.

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References

1. Soeters HM, Blain A, Pondo T, et al. Current epidemiology and trends in invasive *Haemophilus influenzae* disease—United States, 2009–2015. Clin Infect Dis 2018;67:881–9. PMID:29509834 https://doi.org/10.1093/cid/ciy187
2. Takala AK, Meurman O, Kleemola M, et al. Preceding respiratory infection predisposing for primary and secondary invasive *Haemophilus influenzae* type b disease. Pediatr Infect Dis J 1993;12:189–95. PMID:8451094 https://doi.org/10.1097/00006454-199303000-00003
3. McLaughlin J, Castrodale L. Revision of the national surveillance case definition for invasive *Haemophilus influenzae* disease. Atlanta, GA: Council of State and Territorial Epidemiologists; 2014. https://cdn.ymaws.com/www.cste.org/resource/resmgr/2014PS/14_ID_05upd.pdf
4. Collins LF, Havers FP, Tunali A, et al. Invasive nontypeable *Haemophilus influenzae* infection among adults with HIV in metropolitan Atlanta, Georgia, 2008–2018. JAMA 2019;322:2399–410. PMID:31860046 https://doi.org/10.1001/jama.2019.18800
5. Briere EC, Rubin L, Moro PL, Cohn A, Clark T, Messonnier N; Division of Bacterial Diseases, National Center for Immunization and Respiratory Diseases, CDC. Prevention and control of *Haemophilus influenzae* type b disease: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep 2014;63(RR-01):1–14. PMID:24572654
6. Kimberlin DW, Barnett ED, Lynfield R, Sawyer MH, editors. *Haemophilus influenzae* infections. In: Red book: 2021–2024 report of the Committee on Infectious Diseases. Itasca, IL: American Academy of Pediatrics; 2021:345–54.
7. Oliver SE, Rubis AB, Soeters HM, et al. Secondary cases of invasive disease caused by encapsulated and nontypeable *Haemophilus influenzae*—10 U.S. jurisdictions, 2011–2018. MMWR Morb Mortal Wkly Rep 2023;72:386–90. PMID:37053119 https://doi.org/10.15585/mmwr.mm7215a2
8. Prasad N, Rhodes J, Deng L, et al. Changes in the incidence of invasive bacterial disease during the COVID-19 pandemic in the United States, 2014–2020. J Infect Dis 2023;227:907–16. PMID:36723871 https://doi.org/10.1093/infdis/jiad028

Use of Respiratory Syncytial Virus Vaccines in Adults Aged ≥60 Years: Updated Recommendations of the Advisory Committee on Immunization Practices — United States, 2024

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Abstract

Respiratory syncytial virus (RSV) is a major cause of respiratory illness and hospitalization in older adults during fall and winter in the United States. The 2023–2024 RSV season was the first during which RSV vaccination was recommended for U.S. adults aged ≥60 years, using shared clinical decision-making. On June 26, 2024, the Advisory Committee on Immunization Practices voted to update this recommendation as follows: a single dose of any Food and Drug Administration–approved RSV vaccine (Arexvy [GSK]; Abrysvo [Pfizer]; or mResvia [Moderna]) is now recommended for all adults aged ≥75 years and for adults aged 60–74 years who are at increased risk for severe RSV disease. Adults who have previously received RSV vaccine should not receive another dose. This report summarizes the evidence considered for these updated recommendations, including postlicensure data on vaccine effectiveness and safety, and provides clinical guidance for the use of RSV vaccines in adults aged ≥60 years. These updated recommendations are intended to maximize RSV vaccination coverage among persons most likely to benefit, by clarifying who is at highest risk and by reducing implementation barriers associated with the previous shared clinical decision-making recommendation. Continued postlicensure monitoring will guide future recommendations.

Introduction

Respiratory syncytial virus (RSV) is a major cause of respiratory illness and hospitalizations in older adults during fall and winter in the United States (*1*). On June 21, 2023, CDC's Advisory Committee on Immunization Practices (ACIP) issued its first adult RSV vaccination recommendation, stating that adults aged ≥60 years may receive a single dose of RSV vaccine, using shared clinical decision-making (*2*).

As of spring 2024, 20%–25% of U.S. adults aged ≥60 years were estimated to have received RSV vaccine,* and the first postlicensure safety and effectiveness data for GSK's Arexvy and Pfizer's Abrysvo became available.† In addition, on May 31, 2024, the Food and Drug Administration (FDA) approved a third RSV vaccine (mResvia [Moderna]) for prevention of RSV-associated lower respiratory tract disease (RSV-LRTD) in adults aged ≥60 years§ (*3*,*4*).

To update adult RSV vaccination recommendations, ACIP considered data from previous meetings; new data from randomized, observer-blind, placebo-controlled clinical trials (RCTs) of mResvia; and postlicensure data on Arexvy and Abrysvo. This report summarizes that evidence and presents updated ACIP recommendations for RSV vaccination in adults aged ≥60 years.¶

Methods

The ACIP Work Group for RSV prevention in adults met at least monthly since July 2023 to consider updates to adult RSV vaccination recommendations, using the Evidence to Recommendation Framework (EtR) to guide its deliberations.** Work Group conclusions were publicly presented to ACIP on June 26, 2024. Full details for Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) are available at https://www.cdc.gov/vaccines/acip/recs/grade/mrna-rsv-vaccine-older-adults.html and https://www.cdc.gov/vaccines/acip/recs/grade/protein-subunit-rsv-vaccines-older-adults.html and for EtR are available at https://www.cdc.gov/

* https://www.cdc.gov/vaccines/imz-managers/coverage/rsvvaxview/index.html

† In this report, RSV vaccine trade names are used to help differentiate between RSV vaccine products because the products have similar generic names. The use of trade names is for identification only and does not indicate endorsement of any specific RSV vaccine product.

§ mResvia is a 1-dose (0.5 mL) mRNA vaccine containing nucleoside-modified mRNA encoding RSV F protein stabilized in the prefusion conformation.

¶ This report summarizes recommendations for nonpregnant adults aged ≥60 years. Recommendations for the use of RSV vaccines in pregnant adults for prevention of RSV-LRTD in infants are available at https://www.cdc.gov/mmwr/volumes/72/wr/mm7241e1.htm

** Through the EtR framework, the Work Group reviewed data on the public health problem caused by RSV, as well as the benefits and harms, value to the target population, acceptability to key stakeholders, feasibility, societal resource use, and equity implications of RSV vaccination.

vaccines/acip/recs/grade/mrna-rsv-vaccine-older-adults-etr.html and https://www.cdc.gov/vaccines/acip/recs/grade/protein-subunit-rsv-vaccines-older-adults-etr.html.

Vaccine Efficacy and Safety

mRNA RSV Vaccine (Moderna mResvia)

In considering recommendations for use of Moderna's mResvia, ACIP reviewed data from two RCTs. A phase 2/3 trial contributed safety and efficacy data from 36,685 immunocompetent participants aged ≥60 years who received a single dose of mResvia (50 μg of mRNA encoding the prefusion RSV F protein) or saline placebo; participants were enrolled on a rolling basis during November 2021–December 2022 (Moderna, mRNA-1345 phase 2/3 clinical trial, unpublished data, 2024) (*5*). A phase 1 trial contributed additional safety data from 106 participants aged 65–79 years who received either the phase 2/3 trial vaccine formulation or placebo (*6*).

Vaccine efficacy. In Moderna's primary efficacy analysis (median per participant postvaccination follow-up time = 3.7 months; range = 0.5–12.6 months), efficacy of 1 dose was 78.7% (95% CI = 62.8%–87.9%) in preventing symptomatic, laboratory-confirmed RSV-LRTD with two or more lower respiratory symptoms and 80.9% (95% CI = 50.1%–92.7%) in preventing RSV-LRTD with three or more lower respiratory symptoms[††] (Table 1) (*7*). Using all available follow-up time (median = 18.8 months per participant; range = 0.5–24 months), efficacy of mResvia was 47.4% (95% CI = 35.0%–57.4%) against RSV-LRTD with two or more symptoms and 48.4% (95% CI = 27.9%–63.1%) against RSV-LRTD with three or more symptoms (Moderna, mRNA-1345 phase 2/3 clinical trial, unpublished data, 2024) (*7*).

Efficacy point estimates were higher during the first 12 months after vaccination compared with the subsequent 12 months. The trial was not powered to estimate efficacy against medically attended RSV illness, including hospitalization, or RSV-associated death.

Vaccine safety. Severe reactogenicity events were more common among mResvia recipients than among placebo recipients[§§] (pooled relative risk = 1.54 [95% CI = 1.40–1.68]); (Supplementary Table, https://stacks.cdc.gov/view/cdc/159161) (*4*). The pooled relative risk for serious adverse events comparing the intervention and control groups was 1.00 (95% CI = 0.95–1.05).[¶¶] No cases of Guillain-Barré syndrome (GBS), other inflammatory neurologic events, myocarditis, or pericarditis were recorded within 42 days after mResvia vaccination.

Protein Subunit RSV Vaccines (GSK Arexvy and Pfizer Abrysvo)

Vaccine effectiveness. Postlicensure data were reviewed from four observational studies of vaccine effectiveness (VE) of protein subunit RSV vaccination against RSV-associated

[††] Lower respiratory symptoms included shortness of breath, cough or fever (≥37.8°C [100.0°F]), wheezing, rales, or rhonchi, sputum production, tachypnea, hypoxemia (new oxygen saturation ≤93% or new or increasing use of supplemental oxygen), or pleuritic chest pain for at least 24 hours. In case of inability to fully assess other clinical parameters, radiologic evidence of pneumonia with RSV infection confirmed by reverse transcription–polymerase chain reaction (RT-PCR) could also be used to confirm RSV-LRTD.

[§§] Relative risk is pooled risk of events across phase 2/3 and phase 1 trials. Severe reactogenicity events were defined as grade 3 or higher solicited local reactions (injection site pain, redness, swelling or induration, and ipsilateral axillary swelling or tenderness) or systemic reactions (fatigue, fever, headache, nausea or vomiting, arthralgia, myalgia, and chills) recorded during days 0–7 after vaccination.

[¶¶] Relative risk is pooled risk of events across phase 2/3 and phase 1 trials. Serious adverse events were defined as any untoward medical occurrence during all available follow-up time that resulted in death, was life threatening, required inpatient hospitalization or prolongation of existing hospitalization, resulted in persistent disability or incapacity, or was a congenital anomaly or birth defect.

TABLE 1. Efficacy of 1 dose of Moderna mResvia vaccine against respiratory syncytial virus–associated lower respiratory tract disease among adults aged ≥60 years during phase 2/3 pivotal efficacy trial — multiple countries, 2021–2024

Efficacy evaluation period	Vaccine efficacy against outcome, % (95% CI)*	
	RSV-associated LRTD with ≥2 symptoms[†]	RSV-associated LRTD with ≥3 symptoms[†]
All available follow-up time[§]	47.4 (35.0 to 57.4)	48.4 (27.9 to 63.1)
14 days–4 months postvaccination[¶]	78.7 (62.8 to 87.9)	80.9 (50.1 to 92.7)
14 days–12 months postvaccination	56.1 (42.2 to 66.7)	54.9 (30.5 to 70.7)
12–24 months postvaccination	30.0 (1.1 to 50.7)	36.0 (−12.6 to 64.3)

Abbreviations: LRTD = lower respiratory tract disease; RSV = respiratory syncytial virus; RT-PCR = reverse transcription–polymerase chain reaction; VE = vaccine efficacy.

* Manufacturer-calculated efficacy based on hazard ratios. Includes events ≥14 days after injection in Moderna's pivotal phase 2/3 trial. For VE against RSV-LRTD with two or more symptoms through 4 months, 95.04% alpha-adjusted CI was provided; for VE against RSV-LRTD with three or more symptoms through 4 months, 95.10% alpha-adjusted CI was provided. For all other VEs reported in the table, 95% CIs were provided. Estimates are available at https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-06-26-28/04-RSV-Adult-Das-508.pdf or are unpublished data provided by Moderna to ACIP Work Group for RSV in Adults, June 2024.

† LRTD symptoms included shortness of breath, cough or fever (≥100.0°F [≥37.8°C]), wheezing or rales or rhonchi, sputum production, tachypnea, hypoxemia (new oxygen saturation ≤93% or new or increasing use of supplemental oxygen), or pleuritic chest pain for ≥24 hours. In case of inability to fully assess other clinical parameters, radiologic evidence of pneumonia with RT-PCR–confirmed RSV infection could also be used to confirm RSV-associated LRTD.

§ Median per-participant postvaccination follow-up time considering all available follow-up time through March 8, 2024 = 18.8 months.

¶ Median per-participant postvaccination follow-up time through November 30, 2022 = 3.7 months; this represents Moderna's primary analysis.

hospitalization among adults aged ≥60 years during the first RSV season after vaccination***; estimates from the general population or among immunocompetent adults only ranged from 75% (95% CI = 50%–87%) to 82% (95% CI = 69%–89%) (*8*). VE was similar across vaccine products (GSK Arexvy and Pfizer Abrysvo) and patient age groups (60–74 years and ≥75 years). In addition, effectiveness was demonstrated among adults aged ≥60 years with certain immunocompromising conditions††† and those with end-stage renal disease.

Vaccine safety: Guillain-Barré syndrome. Postlicensure safety data were reviewed from an FDA self-controlled case series analysis estimating risk for GBS attributable to protein subunit RSV vaccination among Medicare beneficiaries aged ≥65 years (*9*). The analysis compared GBS incidence during a risk interval (days 1–42 postvaccination) with that during a control interval (days 43–90 postvaccination). Among beneficiaries vaccinated before October 8, 2023, the GBS adjusted incidence rate ratio in the risk interval versus the control interval was 2.30 (95% CI = 0.39–13.72) for GSK's Arexvy and 4.48 (95% CI = 0.88–22.90) for Pfizer's Abrysvo. In this analysis, GBS cases were identified using medical claims data and were not yet confirmed by review of medical records; a final analysis will incorporate medical record review for confirmation of GBS diagnoses and will include additional adults vaccinated later in the 2023–2024 RSV season. Overall, results from this initial analysis did not provide clear, conclusive evidence of an elevated risk for GBS associated with RSV vaccination in older adults, but an elevated risk of GBS could not be ruled out. GBS safety surveillance is ongoing and additional analyses are underway.

Vaccine safety: immune thrombocytopenia. Results of rapid cycle analysis performed by the Vaccine Safety Datalink§§§ demonstrated a statistical signal for immune thrombocytopenia (ITP) in a risk interval (days 1–21) after GSK Arexvy vaccination, without simultaneous receipt of another vaccine, compared with a comparison interval (days 22–42)¶¶¶ (*10*). However, medical record review revealed that onset of most ITP cases occurred before vaccination; onset after vaccination occurred in only four cases identified during the risk interval and one case during the comparison interval. Because of the small number of cases, an association cannot be confirmed between GSK Arexvy vaccination and ITP; supplementary evaluation of identified cases and monitoring for additional cases are ongoing.

Balance of benefits and risks. In a modeling study, estimated public health benefits of protein subunit RSV vaccination were compared with potential GBS risk. Benefits were estimated using observational VE, surveillance data on incidence of RSV-associated outcomes, and RCT evidence of duration of vaccine-conferred protection; risk for GBS was estimated from the FDA self-controlled case series analysis (*11*). Estimated RSV-associated hospitalizations, intensive care unit admissions, and deaths preventable over two consecutive RSV seasons per 1 million RSV vaccine doses administered exceeded estimated numbers of potential vaccine-attributable GBS cases but varied by age and risk group (Table 2). Study limitations included inability to evaluate all risk factors that might be associated with severe RSV disease, uncertainty in VE beyond 4 months postvaccination, and estimates of GBS risk based on few identified cases.

Recommendations for Use of RSV Vaccines for Prevention of RSV-Associated Disease in Adults Aged ≥60 Years

On June 26, 2024, ACIP recommended a single dose of any FDA-approved RSV vaccine for all adults aged ≥75 years and for adults aged 60–74 years who are at increased risk for severe RSV disease.**** Adults who have previously received RSV vaccine should not receive another dose. Adults aged 60–74 years who are at increased risk include persons with certain chronic medical conditions, persons with moderate or severe immune compromise, and persons living in nursing homes (Box). These recommendations replace the June 2023 shared clinical decision-making recommendation for RSV vaccination for adults aged ≥60 years and apply to all RSV vaccines licensed for adults aged ≥60 years (i.e., Arexvy [GSK], Abrysvo [Pfizer], or mResvia [Moderna]).

Qualified vaccinators, including pharmacists, nurse practitioners, and other providers (based on state and jurisdictional law) may determine patient eligibility for RSV vaccination based on clinical assessment even in the absence of medical documentation of a named risk condition. Patient attestation

*** VE estimates came from four studies: CDC's VISION Network included separate estimates for those aged ≥60 years with and without immune compromise; both CDC's IVY Network and the Veteran's Health Administration included estimates among the general population of adults aged ≥60 years, regardless of immune compromise status; Medicare estimates included adults aged ≥65 years with end-stage renal disease.

††† Immune compromise was broadly defined. No estimates of VE are currently available specifically among persons with solid organ or hematopoietic stem cell transplant.

§§§ https://www.cdc.gov/vaccinesafety/ensuringsafety/monitoring/vsd/index.html

¶¶¶ GSK Arexvy accounted for 87.7% of RSV vaccine doses in the Vaccine Safety Datalink. If present, an association between Pfizer Abrysvo and ITP with a similar effect size might not have been detected because fewer doses were recorded.

**** ACIP passed two unanimous motions (vote = 11–0) recommending that adults aged ≥75 years receive a single dose of RSV vaccine and recommending that those aged 60–74 years who are at increased risk for severe RSV disease receive a single dose of RSV vaccine.

TABLE 2. Estimated respiratory syncytial virus–associated outcomes preventable over two consecutive respiratory syncytial virus seasons and potential vaccine-attributable cases of Guillain-Barré syndrome per 1 million protein subunit respiratory syncytial virus vaccine doses administered among adults aged ≥60 years* — United States, 2024

Vaccine product/Recipient age and risk groups	No. of estimated RSV-associated outcomes preventable per 1 million protein subunit RSV vaccine doses administered (range)†,§			No. of estimated vaccine-attributable GBS cases (range)¶
	Hospitalizations	ICU admissions	Deaths	
GSK Arexvy				
≥75 yrs	4,283 (2,235–6,957)	630 (329–1,023)	605 (202–1,263)	3 (0–10)††
60–74 yrs; ≥1 chronic medical condition**	2,839 (1,478–4,699)	647 (337–1,071)	246 (83–436)	
60–74 yrs; no chronic medical conditions**	456 (247–731)	72 (39–115)	39 (16–71)	
Pfizer Abrysvo				
≥75 years	3,817 (1,927–6,288)	561 (283–924)	539 (190–1,106)	16 (3–29)
60–74 yrs; ≥1 chronic medical condition**	2,530 (1,363–4,224)	577 (311–963)	219 (74–399)	
60–74 yrs; no chronic medical conditions**	406 (219–679)	64 (34–107)	35 (14–63)	

Abbreviations: ACIP = Advisory Committee on Immunization Practices; GBS = Guillain-Barré syndrome; ICU = intensive care unit; RSV = respiratory syncytial virus.

* https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-06-26-28/09-RSV-Adult-Hutton-508.pdf

† Preventable outcomes over two RSV seasons were estimated using data from observational studies and clinical trials. Age- and risk-stratified annual incidence of RSV-associated outcomes was from analyses using the RSV Hospitalization Surveillance Network (RSV-NET) and the Behavioral Risk Factor Surveillance System (https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-02-28-29/03-RSV-Adults-Woodruff-508.pdf). Vaccine effectiveness in preventing outcomes was from CDC's VISION Network during October 1, 2023–March 31, 2024 (https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-06-26-28/07-RSV-Adult-Surie-508.pdf). Waning of vaccine effectiveness over two seasons was from waning of clinical trial efficacy against RSV-associated lower respiratory tract disease.

§ Ranges in estimated preventable disease incorporated uncertainty in incidence of RSV-associated outcomes and in vaccine effectiveness, using Monte Carlo simulation.

¶ Product-specific risk of vaccine-attributable GBS was based on initial results of a Food and Drug Administration self-controlled case series analysis among Medicare beneficiaries aged ≥65 years who received RSV vaccine before October 8, 2023. The analysis compared GBS incidence during a risk interval (days 1–42 postvaccination) with that in a control interval (days 43–90 postvaccination). https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-06-26-28/06-RSV-Adult-Lloyd-508.pdf

** Chronic medical conditions considered in the model included chronic obstructive pulmonary disease, asthma, coronary artery disease, diabetes mellitus, chronic kidney disease, and severe obesity (body mass index ≥40 kg/m^2). No chronic medical conditions was defined as absence of at least one of these conditions.

†† Self-controlled case series analysis estimated vaccine-attributable risk of three (95% CI = −3 to 10) GBS cases. However, the range was truncated at zero for benefit-risk analyses.

is sufficient evidence of the presence of a risk factor; vaccinators should not deny RSV vaccination to a person because of lack of documentation. These factors should be considered to optimize patient access, including in administrative procedures, such as reimbursement policies for RSV vaccination.

Rationale for Recommendations

The 2023 shared clinical decision-making RSV vaccination recommendation was made in the setting of uncertainty in some portions of the evidence profile. RCTs of both protein subunit vaccines (GSK Arexvy and Pfizer Abrysvo) were underpowered to demonstrate protection against RSV-associated hospitalization or death, and enrolled few participants who were frail or aged ≥75 years. Although both vaccines were well-tolerated and exhibited an acceptable safety profile, a small number of inflammatory neurologic events, including GBS, were observed after RSV vaccination in clinical trials. Because of the small number of GBS cases in the trials, it was unclear whether they represented an association between RSV vaccination and GBS or occurred because of chance alone. Acknowledging these uncertainties, in June 2023 ACIP recommended shared clinical decision-making to encourage providers and patients to consider individual risk of RSV disease (*2*); however, shared clinical decision-making has drawbacks. Providers find it confusing and time-consuming to implement (*12*,*13*). After one season of RSV vaccine availability, vaccination coverage among adults with chronic medical conditions has been only modestly higher than that among adults without conditions (*14*). The challenges of shared clinical decision-making, along with the updated evidence on balance of benefits and risks, led ACIP in June 2024 to make an age-based recommendation for adults aged ≥75 years and a risk-based recommendation for those aged 60–74 years. These updated recommendations are intended to maximize RSV vaccination coverage among persons most likely to benefit, by clarifying who is at highest risk and by reducing implementation barriers associated with the previous shared clinical decision-making recommendation (*15*).

ACIP recognized that a risk-based recommendation for adults aged 60–74 years might result in lower RSV vaccination coverage among persons at increased risk compared with an age-based recommendation for this group (*16*). However, ACIP judged that postlicensure safety surveillance suggests a potential increased risk for GBS after protein subunit RSV vaccination (GSK Arexvy and Pfizer Abrysvo), and although no GBS signal was observed after Moderna mResvia vaccination in RCTs, postlicensure safety surveillance has yet to occur. Based on currently available evidence, ACIP concluded that the benefits of RSV vaccination did not clearly outweigh the potential harms in adults aged 60–74 years without risk

BOX. Risk factors for severe respiratory syncytial virus disease among adults aged 60–74 years*

- Chronic cardiovascular disease (e.g., heart failure, coronary artery disease, or congenital heart disease [excluding isolated hypertension])
- Chronic lung or respiratory disease (e.g., chronic obstructive pulmonary disease, emphysema, asthma, interstitial lung disease, or cystic fibrosis)
- End-stage renal disease or dependence on hemodialysis or other renal replacement therapy
- Diabetes mellitus complicated by chronic kidney disease, neuropathy, retinopathy, or other end-organ damage, or requiring treatment with insulin or sodium-glucose cotransporter-2 (SGLT2) inhibitor
- Neurologic or neuromuscular conditions causing impaired airway clearance or respiratory muscle weakness (e.g., poststroke dysphagia, amyotrophic lateral sclerosis, or muscular dystrophy [excluding history of stroke without impaired airway clearance])
- Chronic liver disease (e.g., cirrhosis)
- Chronic hematologic conditions (e.g., sickle cell disease or thalassemia)
- Severe obesity (body mass index ≥40 kg/m^2)
- Moderate or severe immune compromise†
- Residence in a nursing home
- Other chronic medical conditions or risk factors that a health care provider determines would increase the risk for severe disease due to viral respiratory infection (e.g., frailty,§ situations in which health care providers have concern for presence of undiagnosed chronic medical conditions, or residence in a remote or rural community where transportation of patients with severe RSV disease for escalation of medical care is challenging¶)

Abbreviation: RSV = respiratory syncytial virus.

* Patient attestation is sufficient evidence of the presence of a risk factor. Vaccinators should not deny RSV vaccination to a person because of lack of medical documentation.

† A list of moderately or severely immunocompromising conditions can be found in the COVID-19 vaccination interim clinical considerations. https://www.cdc.gov/vaccines/covid-19/clinical-considerations/interim-considerations-us.html#immunocompromised

§ Frailty is a multidimensional geriatric syndrome that reflects a state of increased vulnerability to adverse health outcomes. Although no consensus definition exists, one frequently used tool for determination is the Fried frailty phenotype assessment (https://pubmed.ncbi.nlm.nih.gov/11253156/) in which frailty is defined as a clinical syndrome with three or more of the following symptoms present: unintentional weight loss (10 lbs [4.5 kg] in the past year), self-reported exhaustion, weakness (grip strength), slow walking speed, or low physical activity.

¶ Health care providers caring for adults aged 60–74 years residing in these communities may use clinical judgement, knowledge of local RSV epidemiology, and community incidence of RSV-associated hospitalization to recommend vaccination for a broader population in this age group.

factors for severe RSV disease. However, ACIP also stressed that research regarding RSV risk factors is ongoing, so providers should continue to have flexibility in offering RSV vaccine to patients they assess to be at increased risk for severe disease even if they do not fall into an explicitly named risk category. As with all vaccines, patients should be informed of the benefits and risks of RSV vaccination (*17*); for protein subunit RSV vaccines, this information includes potential risk for GBS.

Clinical Guidance

Administration of RSV vaccine with other adult vaccines during the same visit is acceptable. Additional information regarding coadministration and regarding contraindications and precautions is available at https://www.cdc.gov/vaccines/vpd/rsv/hcp/older-adults.html.

Timing of RSV Vaccination

Eligible adults are currently recommended to receive a single dose of RSV vaccine; adults who have already received RSV vaccination should not receive another dose. A single dose provides protection for at least two RSV seasons. The need for additional RSV vaccine doses will be evaluated by ACIP in the future; ACIP will update recommendations as needed.

Eligible adults who have not previously received RSV vaccination may be vaccinated at any time of year, but vaccination will have the most benefit if administered in late summer or early fall, just before the RSV season. In most of the continental United States, this corresponds to vaccination during August–October.

Reporting of Vaccine Adverse Events

Adverse events after vaccination should be reported to the Vaccine Adverse Event Reporting System (VAERS). Reporting of any clinically significant adverse event is encouraged, even if it is uncertain whether the vaccine caused the event. Information on how to submit a report to VAERS is available at https://vaers.hhs.gov/index.html or by telephone at 1-800-822-7967.

Summary

What is already known about this topic?

On June 21, 2023, the Advisory Committee on Immunization Practices (ACIP) recommended that adults aged ≥60 years may receive a single dose of respiratory syncytial virus (RSV) vaccine, using shared clinical decision-making.

What is added by this report?

On June 26, 2024, ACIP voted to update these recommendations as follows: all adults aged ≥75 years and adults aged 60–74 years who are at increased risk for severe RSV disease should receive a single dose of RSV vaccine.

What are the implications for public health practice?

These updated recommendations are intended to maximize RSV vaccination coverage among persons most likely to benefit. Continued postlicensure monitoring will guide future recommendations.

Future RSV Vaccine Policy for Adults

On June 7, 2024, FDA approved use of GSK's Arexvy in adults aged 50–59 years who are at increased risk for RSV-LRTD (*18*). As of June 2024, ACIP judged that insufficient evidence was available to inform a vote on RSV vaccination policy in adults aged 50–59 years who are at increased risk for RSV disease. Before voting on a recommendation in this age group, ACIP expressed that the following items are needed: updated RSV vaccine safety analyses among adults aged ≥60 years, including results from the full 2023–2024 RSV season in the FDA analysis incorporating chart confirmation of GBS diagnoses; additional data on duration of protection from RSV vaccination and immune response after revaccination; and immunogenicity data in adults with immunocompromise. ACIP will review evidence and vote on RSV vaccination policy in this age group when additional data are available.

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References

1. McLaughlin JM, Khan F, Begier E, Swerdlow DL, Jodar L, Falsey AR. Rates of medically attended RSV among US adults: a systematic review and meta-analysis. Open Forum Infect Dis 2022;9:ofac300. PMID:35873302 https://doi.org/10.1093/ofid/ofac300
2. Melgar M, Britton A, Roper LE, et al. Use of respiratory syncytial virus vaccines in older adults: recommendations of the Advisory Committee on Immunization Practices—United States, 2023. MMWR Morb Mortal Wkly Rep 2023;72:793–801. PMID:37471262 https://doi.org/10.15585/mmwr.mm7229a4
3. Food and Drug Administration. MRESVIA [Approval letter]. Silver Spring, MD: US Department of Health and Human Services, Food and Drug Administration; 2024. https://www.fda.gov/media/179015/download?attachment
4. Food and Drug Administration. MRESVIA [Package insert]. Silver Spring, MD: US Department of Health and Human Services; 2024. https://www.fda.gov/media/179005/download
5. Wilson E, Goswami J, Baqui AH, et al.; ConquerRSV Study Group. Efficacy and safety of an mRNA-based RSV PreF vaccine in older adults. N Engl J Med 2023;389:2233–44. PMID:38091530 https://doi.org/10.1056/NEJMoa2307079
6. Shaw CA, Essink B, Harper C, et al. Safety and immunogenicity of an mRNA-based RSV vaccine including a 12-month booster in a phase I clinical trial in healthy older adults. J Infect Dis 2024;jiae081. PMID:38385566 https://doi.org/10.1093/infdis/jiae081
7. Das R. Update on Moderna's RSV vaccine, mRESVIA (mRNA-1345), in adults ≥60 years of age [Presentation slides]. Presented at the Advisory Committee on Immunization Practices meeting, Atlanta, GA; June 26, 2024. https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-06-26-28/04-RSV-Adult-Das-508.pdf

8. Surie D. Effectiveness of adult respiratory syncytial virus (RSV) vaccines, 2023–2024 [Presentation slides]. Presented at the Advisory Committee on Immunization Practices meeting, Atlanta, GA; June 26, 2024. https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-06-26-28/07-RSV-Adult-Surie-508.pdf
9. Lloyd P. Evaluation of Guillain-Barre syndrome (GBS) following RSV vaccination among adults 65 years and older [Presentation slides]. Presented at the Advisory Committee on Immunization Practices meeting, Atlanta, GA; June 26, 2024. https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-06-26-28/06-RSV-Adult-Lloyd-508.pdf
10. Donahue J. Update: rapid cycle analysis of RSV vaccines in older adults [Presentation slides]. Presented at the Advisory Committee on Immunization Practices meeting, Atlanta, GA; June 26, 2024. https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-06-26-28/05-RSV-Adult-Donahue-508.pdf
11. Hutton D. Risk-benefit analysis of RSV vaccination in older adults [Presentation slides]. Presented at the Advisory Committee on Immunization Practices meeting, Atlanta, GA; June 26, 2024. https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-06-26-28/09-RSV-Adult-Hutton-508.pdf
12. Kempe A, Lindley MC, O'Leary ST, et al. Shared clinical decision-making recommendations for adult immunization: what do physicians think? J Gen Intern Med 2021;36:2283–91. PMID:33528783 https://doi.org/10.1007/s11606-020-06456-z
13. Black C. RSV vaccination implementation update [Presentation slides]. Presented at the Advisory Committee on Immunization Practices meeting, Atlanta, GA; February 29, 2024. https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-02-28-29/04-RSV-Adults-Black-508.pdf
14. Black CL, Kriss JL, Razzaghi H, et al. Influenza, updated COVID-19, and respiratory syncytial virus vaccination coverage among adults—United States, fall 2023. MMWR Morb Mortal Wkly Rep 2023;72:1377–82. PMID:38127675 https://doi.org/10.15585/mmwr.mm7251a4
15. Melgar M, Britton A, Roper LE. Evidence to recommendations framework (EtR): RSV vaccination in adults aged 50–59 years, 60–74 years, and 75 years and older [Presentation slides]. Presented at the Advisory Committee on Immunization Practices meeting, Atlanta, GA; June 26, 2024. https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2024-06-26-28/11-RSV-Adult-Melgar-Roper-Britton-508.pdf
16. Weng MK, Doshani M, Khan MA, et al. Universal hepatitis B vaccination in adults aged 19–59 years: updated recommendations of the Advisory Committee on Immunization Practices—United States, 2022. MMWR Morb Mortal Wkly Rep 2022;71:477–83. PMID:35358162 https://doi.org/10.15585/mmwr.mm7113a1
17. Kroger A, Bahta L, Long S, Sanchez P. General best practice guidelines for immunization. 2023; https://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/index.html
18. Food and Drug Administration. AREVY [Package insert]. Silver Spring, MD: U.S. Department of Health and Human Services, Food and Drug Administration; 2024. https://www.fda.gov/media/167805/download

Notes from the Field

Universal Newborn Screening and Surveillance for Congenital Cytomegalovirus — Minnesota, 2023–2024

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Summary

What is already known about this topic?

Congenital cytomegalovirus (cCMV) is the most frequent infectious cause of birth defects and the most common nongenetic cause of permanent hearing loss in U.S. children.

What is added from this report?

Universal newborn screening and population-based surveillance for cCMV, implemented in Minnesota in 2023, identified an observed cCMV prevalence of 0.3% of Minnesota live births. Nearly all cCMV cases detected through newborn screening were confirmed with diagnostic testing; most infants received comprehensive evaluations and linkage to care, leading to the detection of unapparent cCMV-specific findings among seven infants.

What are the implications for public health practice?

Universal newborn screening identified infants with neurologic abnormalities and those with or at risk for cCMV-associated permanent hearing loss and other sequelae, who might have been missed by routine care or targeted screening.

Congenital cytomegalovirus (cCMV) is the most frequent infectious cause of birth defects and the most frequent nongenetic cause of permanent hearing loss in U.S. children; cCMV affects approximately 0.5% of U.S. births. Among infants with cCMV infection, approximately 10% have clinical findings at birth (*1*). Early identification of cCMV infection could improve outcomes through the use of antiviral therapy when indicated, and audiology and developmental screenings (*1*). A recent Minnesota study found average dried blood spot sensitivity of 75% for detection of cCMV infection (*2*). In February 2023, Minnesota became the first U.S. state to implement universal newborn screening for cCMV. To evaluate performance and feasibility of newborn screening and to describe the epidemiology of cCMV, statewide surveillance was initiated. This report describes the first year of these activities.

Investigation and Outcomes

Minnesota Department of Health Newborn Screening Recommendations

Unless parents opt out, all Minnesota-born infants are screened for the presence of cytomegalovirus (CMV) using a qualitative real-time polymerase chain reaction (PCR) assay performed on a dried blood spot at the Minnesota Department of Health.* Infants whose assay detects CMV are recommended to have diagnostic PCR testing, performed on urine, within the first 21 days of life. For infants with diagnosed cCMV, recommended evaluations include complete blood count, liver function testing, neuroimaging, and audiologic and ophthalmologic assessments. In addition, infants with evidence of CMV infection† within the first 90 days of life are voluntarily reported to the Minnesota Department of Health by clinicians or through electronic laboratory reporting. The Minnesota Department of Health newborn screening program follows all identified infants with cCMV to ensure linkage to care and to evaluate long-term outcomes.

2023–2024 cCMV Surveillance Findings

During February 6, 2023–February 5, 2024, the Minnesota Department of Health screened 60,115 infants, 184 (0.31%) of whom had CMV detected; 174 detections (0.29%) occurred during the first 21 days of life, and 10 (0.02%) after age 21 days. Among the 174 infants with CMV detected during the first 21 days of life, confirmatory testing was completed for 170 (98%), including 164 (96%) before age 21 days; CMV was detected in 169 (99%) of these infants. In addition, three infants with cCMV who had a negative test result during CMV newborn screening were identified by clinician or laboratory reporting. Among all 187 infants, 176 (94%) met the confirmed case definitions (21 [12%] with cCMV disease; 155 [88%] with cCMV infection)§ (*3*); 11 (6%) infants did not meet the case definition.

Among the 176 confirmed cases of cCMV disease or cCMV infection, neuroimaging, audiology, and ophthalmology assessments were completed for 160 (91%), 157 (89%) and 141 (80%) infants, respectively; 132 (75%) completed all three

* https://www.health.state.mn.us/people/newbornscreening/program/newbornscreeningpanel.pdf

† Evidence of CMV infection includes CMV-positive culture, antigen, or nucleic acid amplification testing, from any specimen source.

§ Council of State and Territorial Epidemiologists public health surveillance case definition: confirmed cases of cCMV infection have confirmatory laboratory evidence of infection. Cases of confirmed cCMV disease meet clinical criteria and have confirmatory laboratory evidence of infection. Clinical criteria include hepatomegaly, splenomegaly, petechial rash or purpura, microcephaly, neuroimaging abnormalities consistent with cCMV, sensorineural hearing loss, seizures, cerebral palsy, chorioretinitis, and vision impairment resulting from conditions consistent with cCMV.

assessments. Fifty-nine (34%) infants had one or more clinical findings identified, most frequently nonspecific neuroimaging abnormalities; not all findings resulted in symptomatic disease (Table). cCMV-consistent findings not detected through routine newborn clinical care were observed in seven infants identified through newborn screening, including two with neuroimaging abnormalities consistent with cCMV. Overall, 29 (16%) infants received nonpassing results for newborn hearing screening. Among 11 (6.3%) infants with permanent hearing loss, four received passing results for newborn hearing screening. Fifteen (8.5%) infants received antiviral therapy. Two infant deaths, both with causes other than cCMV listed, were identified. The observed prevalence of cCMV in Minnesota was 0.29% of live births.

Preliminary Conclusions and Actions

Universal cCMV newborn screening was implemented in Minnesota in 2023; nearly all cases (99%) in infants with positive newborn screening results during February 2023–February 2024 were confirmed by diagnostic testing, and most infants (75%) had comprehensive evaluations and linkage to care. The observed cCMV prevalence was lower than the 0.45% estimated in an earlier Minnesota study performed during 2016–2019 (*2*). Three cases of cCMV in infants who had negative newborn screening test results for CMV were voluntarily reported to the Minnesota Department of Health. Further evaluation of the newborn screening using dried blood spot sensitivity is warranted inclusive of improving case reporting

TABLE. Characteristics of confirmed cases of congenital cytomegalovirus, by case classification* — Minnesota, 2023–2024

Characteristic	No. (%) Confirmed cCMV disease* n = 21	Confirmed cCMV infection* n = 155	Total N = 176
Ascertainment method			
cCMV detected on newborn screen	21 (100.0)	152 (98.1)	**173 (98.3)**
Clinician or laboratory reporting	0 (—)	3 (1.9)	**3 (1.7)**
Newborn hearing screen			
Referred/Did not pass	9 (42.9)	20 (12.9)	**29 (16.5)**
Recommended evaluation completed			
Audiology	21 (100.0)	136 (87.7)	**157 (89.2)**
Neuroimaging	20 (95.2)	140 (90.3)	**160 (90.9)**
Ophthalmology	18 (85.7)	123 (79.4)	**141 (80.1)**
All three evaluations	18 (85.7)	114 (73.5)	**132 (75.0)**
Clinical findings			
Anemia	2 (9.5)	3 (1.9)	**5 (2.8)**
Cerebral palsy†	0 (—)	—	**0 (—)**
Chorioretinitis†	0 (—)	—	**0 (—)**
Elevated liver enzymes	2 (9.5)	8 (5.2)	**10 (5.7)**
Hepatomegaly†	2 (9.5)	—	**2 (1.1)**
Hydrops	0 (—)	0 (—)	**0 (—)**
Intrauterine growth restriction	3 (14.3)	8 (5.2)	**11 (6.3)**
Jaundice	2 (9.5)	8 (5.2)	**10 (5.7)**
Microcephaly†	7 (33.3)	—	**7 (4.0)**
Neuroimaging abnormality, consistent with cCMV†,§	5 (23.8)	—	**5 (2.8)**
Neuroimaging abnormality, nonspecific¶	8 (38.1)	19 (12.3)	**27 (15.3)**
Permanent hearing loss†,**	11 (52.4)	—	**11 (6.3)**
Petechial rash or purpura†	2 (9.5)	—	**2 (1.1)**
Seizures†	0 (—)	—	**0 (—)**
Small for gestational age	3 (14.3)	8 (5.2)	**11 (6.3)**
Splenomegaly†	1 (4.8)	—	**1 (0.6)**
Thrombocytopenia	2 (9.5)	2 (1.3)	**4 (2.3)**
Vision impairment†	0 (—)	—	**0 (—)**
Antiviral therapy initiated	8 (38.1)	7 (4.5)	**15 (8.5)**
Infant death	0 (—)	2 (1.3)	**2 (1.1)**

Abbreviation: cCMV = congenital cytomegalovirus.

* Confirmed cases of cCMV infection have confirmatory laboratory evidence of infection. Cases of confirmed cCMV disease meet clinical criteria and have confirmatory laboratory evidence of infection. https://ndc.services.cdc.gov/case-definitions/congenital-cytomegalovirus-ccmv-infection-and-disease

† Denotes clinical findings listed in clinical criteria for national cCMV disease case definition.

§ Neuroimaging abnormality, consistent with cCMV, is defined as presence of calcifications, cerebellar or cortical malformations, periventricular echogenicity or leukomalacia, ventriculomegaly, or migrational abnormalities.

¶ Includes other neuroimaging findings that are not considered consistent with cCMV (e.g., cerebral cysts, vasculopathy, and white matter changes). https://pubmed.ncbi.nlm.nih.gov/28291720/

** Permanent hearing loss as documented at the most recent audiologic diagnostic assessment.

through a disease reporting mandate, which is presently underway in Minnesota. The inclusion of statewide population-based surveillance for cCMV complemented and helped the evaluation of case ascertainment by newborn screening. This comprehensive approach, along with long-term follow-up, will guide development and implementation of cCMV screening policy and facilitate understanding of the incidence of cCMV and identification of groups at increased risk.

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References

1. Cytomegalovirus infection [Chapter 22]. In: Kimberlin DW, Banerjee R, Barnett ED, Lynfield R, Sawyer MH, eds. American Academy of Pediatrics red book: 2024–2027 report of the Committee on Infectious Diseases. Itasca, IL: American Academy of Pediatrics; 2024:334–52. https://publications.aap.org/redbook/book/347/chapter/5751423/Cytomegalovirus-Infection
2. Dollard SC, Dreon M, Hernandez-Alvarado N, et al. Sensitivity of dried blood spot testing for detection of congenital cytomegalovirus infection. JAMA Pediatr 2021;175:e205441. PMID:33523119 https://doi.org/10.1001/jamapediatrics.2020.5441
3. CDC. Congenital cytomegalovirus (cCMV) infection and disease 2024 case definition. Atlanta, GA: US Department of Health and Human Services, CDC; 2024. https://ndc.services.cdc.gov/case-definitions/congenital-cytomegalovirus-ccmv-infection-and-disease

Notes from the Field

Heightened Precautions for Imported Dogs Vaccinated with Potentially Ineffective Rabies Vaccine — United States, August 2021–April 2024

Mark S. Freedman, DVM[1]; Samantha D. Swisher, DVM[1,2]; Ryan M. Wallace, DVM[3]; Mark E. Laughlin, DVM[1]; Clive M. Brown, MBBS[1]; Emily G. Pieracci, DVM[1]

The United States has been free of dog-maintained rabies virus variants since 2007 (*1*). Proof of vaccination against rabies is required for dogs imported into the United States from countries with a high risk for rabies*,†; however, some vaccines licensed abroad might not meet international vaccine production standards, and therefore, might not provide adequate protection (*2*). In July 2021 and January 2022, two dogs imported into Canada from Iran received a diagnosis of rabies (*3*,*4*). Both dogs had documentation of vaccination with Canvac R (Dyntec)§ rabies vaccine, manufactured in the Czech Republic (Canadian Food Inspection Agency and Public Health Agency, Canada, personal communication, 2021). At the time of these importations, global rabies laboratory reference centers had concerns about this vaccine's potency and alerted Canadian and U.S. officials to a potential issue regarding dogs vaccinated with this product. A 2023 evaluation of eight veterinary rabies vaccines marketed in Sri Lanka reported that the Canvac R vaccine did not meet international potency standards (*2*).

Investigation and Outcomes

In July 2021, CDC enacted a temporary suspension of dog importations from countries with a high risk for rabies to address an increase in the number of imported dogs with inadequate documentation of rabies vaccination during the COVID-19 pandemic.¶ Under this suspension, one option for persons importing dogs from high-risk countries that had been vaccinated abroad was to apply for a CDC dog import permit.** CDC's dog import permit collected administered rabies vaccine product information. The conditions of the permit required that these dogs receive a rabies vaccine booster from a USDA-accredited U.S. veterinarian within 10 days after arriving in the United States; however, compliance was not routinely confirmed. In January 2022, CDC implemented retrospective and prospective monitoring of rabies revaccination among dogs who received Canvac R before importation. Among 63,618 approved permits, CDC identified 132 (0.2%) permits issued during August 2021–April 2024 for dogs vaccinated with Canvac R. These dogs originated in 17 high-risk countries and had final destinations in 28 U.S. states.

CDC emailed 132 applicants who had filed permit requests for dogs vaccinated with Canvac R prior to importation to obtain confirmation of revaccination in the United States. If no response was received after two attempts, the applicant's information was shared for follow-up with the state public health veterinarian in the dog's destination state.

Applicants of eight permits reported they did not import their dogs into the United States. For the remaining 124, importers of 102 (82%) dogs provided CDC proof of revaccination. The remaining 22 cases were referred to state and local health departments, which were able to confirm revaccination for an additional 14 dogs (Table). Either CDC or the dog's destination state confirmed revaccination for 116 dogs (94%) and, as of May 2024, no signs of rabies had been reported in any of the dogs.

Preliminary Conclusions and Actions

Because CDC import permit applications collected vaccine product information, CDC was able to implement public health precautions for dogs vaccinated with Canvac R, a rabies vaccine with demonstrated low potency (*2*). CDC worked with state and local health departments to ensure that these dogs received a U.S. Department of Agriculture–licensed rabies vaccine after arrival, protecting dogs, pet owners, and U.S. communities. Although CDC might not be able to monitor and respond to all reports of vaccine failure, this investigation is an example of best practices for preventing importation and possible reintroduction of dog-maintained rabies virus variants into the United States. To increase CDC's ability to close this gap, CDC's updated dog importation regulation, effective August 1, 2024, requires revaccination upon arrival of all foreign-vaccinated dogs from high-risk countries at a CDC-registered animal care facility, regardless of the preimportation vaccine administered.

* https://www.federalregister.gov/documents/2024/05/13/2024-09676/control-of-communicable-diseases-foreign-quarantine-importation-of-dogs-and-cats

† https://www.cdc.gov/importation/dogs/high-risk-countries.html

§ https://dyntec.cz/en/product/canvac-r-en/

¶ https://www.federalregister.gov/documents/2021/06/16/2021-12418/temporary-suspension-of-dogs-entering-the-united-states-from-high-risk-rabies-countries; https://www.federalregister.gov/documents/2023/07/10/2023-14342/extension-of-temporary-suspension-of-dogs-entering-the-united-states-from-countries-with-a-high-risk

** As an alternative to applying for a permit, importers had the option of making a reservation at a CDC-registered animal care facility, where their dog's rabies vaccination records were reviewed, and any necessary follow-up services (including rabies revaccination) were provided.

TABLE. Public health follow-up and revaccination rates for imported dogs with a history of receiving Canvac R rabies vaccine* before importation — United States, August 2021–April 2024

Country of origin	No. of CDC dog import permits issued	No. (%)† of dogs that traveled to United States	Proof of rabies revaccination provided to CDC	Proof of rabies revaccination provided to state§	Total no. (%)¶ with proof of revaccination provided
India	46	44 (96)	37	5	**42 (95)**
Iran	39	34 (87)	26	6	**32 (94)**
Qatar	15	14 (93)	14	0	**14 (100)**
United Arab Emirates	10	10 (100)	7	0	**7 (70)**
Pakistan	4	4 (100)	4	0	**4 (100)**
Uganda	3	3 (100)	3	0	**3 (100)**
Bangladesh	2	2 (100)	0	2	**2 (100)**
Morocco	2	2 (100)	2	0	**2 (100)**
Peru	2	2 (100)	2	0	**2 (100)**
Tanzania	2	2 (100)	1	1	**2 (100)**
Georgia	1	1 (100)	1	0	**1 (100)**
Jordan	1	1 (100)	1	0	**1 (100)**
Lebanon	1	1 (100)	1	0	**1 (100)**
Moldova	1	1 (100)	1	0	**1 (100)**
Nepal	1	1 (100)	0	0	**0 (—)**
Senegal	1	1 (100)	1	0	**1 (100)**
Togo	1	1 (100)	1	0	**1 (100)**
Total	**132**	**124 (94)**	**102**	**14**	**116 (94)**

* https://dyntec.cz/en/product/canvac-r-en/
† Percentage of dogs for which an import permit was issued.
§ California (five), Virginia (three), New Jersey (two), Pennsylvania (two), Illinois (one), and Texas (one).
¶ Percentage of dogs vaccinated with Canvac R that traveled to the United States.

Summary

What is already known about this topic?

Prearrival rabies vaccination is required for dogs imported into the United States from countries at high risk for dog-maintained rabies virus variants; however, some commercial rabies vaccines used outside the United States might not provide adequate protection.

What is added by this report?

During August 2021–May 2024, a total of 132 dogs imported from high-risk countries and vaccinated outside the United States with a potentially ineffective vaccine were identified and revaccinated.

What are the implications for public health?

Requiring detailed information about importers and dogs' vaccination histories permits targeted interventions if specific vaccine products are suspected to be ineffective.

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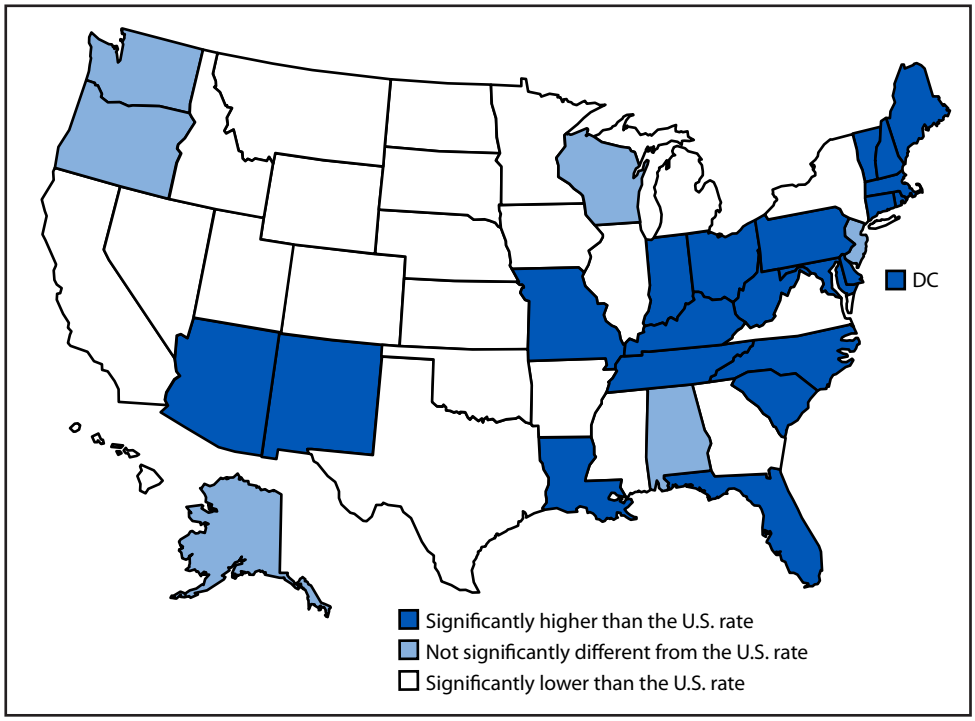
References

1. Velasco-Villa A, Reeder SA, Orciari LA, et al. Enzootic rabies elimination from dogs and reemergence in wild terrestrial carnivores, United States. Emerg Infect Dis 2008;14:1849–54. PMID:19046506 https://doi.org/10.3201/eid1412.080876
2. Rathnadiwakara H, Gunatilake M, Servat A, Wasniewski M, Thibault JC, Cliquet F. Potency of veterinary rabies vaccines marketed in Sri Lanka. Vaccines (Basel) 2023;11:961–70. PMID:37243065 https://doi.org/10.3390/vaccines11050961
3. Rebellato S, Choi M, Gitelman J, et al. Rabies in an imported dog, Ontario, 2021. Can Commun Dis Rep 2022;48:238–42. PMID:37333573 https://doi.org/10.14745/ccdr.v48i06a01
4. Di Salvo P, Anderson M, Fehlner-Gardiner C, et al. Rabies in an imported dog, Ontario, Canada, 2022. Can Commun Dis Rep 2023;49:1–4. PMID:36815867 https://doi.org/10.14745/ccdr.v49i01a01

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Drug Overdose Death* Rates,† by State — United States, 2022



Abbreviation: DC = District of Columbia.
* Drug overdose deaths were identified using *International Classification of Diseases, Tenth Revision* underlying cause-of-death codes X40–X44, X60–X64, X85, and Y10–Y14.
† Age-adjusted drug overdose death rates were calculated using the direct method and the 2000 U.S. standard population.

In 2022, 21 states and the District of Columbia had drug overdose death rates that were higher than the national age-adjusted rate of 32.6 deaths per 100,000 standard population. Rates were generally higher among eastern jurisdictions, including the two jurisdictions with the highest rates, West Virginia (80.9) and the District of Columbia (64.3), although rates were also higher than the U.S. average in Arizona, Louisiana, Missouri and New Mexico.

Supplementary Table: https://stacks.cdc.gov/view/cdc/159285

Source: National Center for Health Statistics, National Vital Statistics System, Mortality Data, 2022. https://wonder.cdc.gov/ucd-icd10-expanded.html

Reported by: Matthew F. Garnett, MPH, Mgarnett@cdc.gov; Arialdi Miniño, MPH.

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

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