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Baylisascariasis (Raccoon Roundworm Infection) in Two Unrelated Children — Los Angeles County, California, 2024

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Abstract

Baylisascaris procyonis (raccoon roundworm), a parasite commonly found in raccoons (*Procyon lotor*), can cause severe disease in humans when it invades visceral organs or the ocular and central nervous systems. Without prompt treatment, *B. procyonis* infection can lead to serious complications and death. During September 2024, the Los Angeles County Department of Public Health was notified of two unrelated pediatric patients with neurologic signs and symptoms consistent with baylisascariasis, including behavioral change, lethargy, and gait instability. The first case occurred in an adolescent aged 14 years who had received a previous diagnosis of autism spectrum disorder and had a history of pica (i.e., ingestion of nonfood items); the second case occurred in a previously healthy child aged 15 months. Both were treated with albendazole and corticosteroids. The first patient returned to baseline neurologic status, but delays in diagnosis and treatment of the second patient resulted in severe neurologic sequelae. Epidemiologic investigations identified raccoon feces that had fallen from a rooftop latrine (i.e., a communal raccoon defecation site) as the possible source of exposure for the adolescent. No source of exposure was identified for the younger child. *B. procyonis* infection should be suspected and prompt treatment considered in patients with neurologic symptoms and cerebrospinal fluid or peripheral blood eosinophilia (>1,000 eosinophils/mL of blood), especially young children or persons with developmental disabilities or pica. In addition, the public should be aware of exposure prevention strategies, including preventing raccoon activity around properties, avoiding exposure to raccoon feces, and safely removing raccoon latrines.

Introduction

Baylisascaris procyonis (raccoon roundworm) is an intestinal parasite that causes widespread, typically asymptomatic infection in raccoons (*Procyon lotor*) in the United States (*1*,*2*), where up to 80% of raccoons in the Northeast, Midwest, and West Coast regions are affected (*3*). Raccoons, the primary definitive host of *B. procyonis*, can shed millions of roundworm eggs in their feces every day. Eggs become infective after 2–4 weeks in the environment and can survive for years. When consumed by nondefinitive hosts, the eggs develop into larvae and migrate through body tissues (*1*). Human cases are rare: only 35 cases have been reported in the United States (*1*,*2*,*4*). Most patients have been young and male with developmental disabilities and pica, conditions associated with compulsive consumption of nonfood items such as soil (*5*). Serious complications include prolonged migration and persistence of helminth larvae in the viscera (visceral larva migrans), the brain (neural larva migrans), and the eye (ocular larva migrans); some cases have been fatal. No vaccine to prevent baylisascariasis exists. In cases in which suspicion of exposure is high (e.g., known oral exposure to raccoon feces), treatment with oral albendazole (25–50 mg/kg per day for 10–20 days) might be appropriate, and should be initiated as soon as possible after ingestion of infectious material, ideally within three days (*6*).

INSIDE

450 Solar Panel Installation Workers Exposed to Pesticides During Two Agricultural Applications — Michigan, August 2023 and May 2024

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

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION

Two cases of *B. procyonis* infection in children were reported to the Los Angeles County Department of Public Health (LACDPH) in 2024. One case occurred in an adolescent aged 14 years who had received a previous diagnosis of autism spectrum disorder and had a history of pica; the second case occurred in a previously healthy child aged 15 months. Both patients experienced neurologic changes and were found to have eosinophilic meningitis. This report describes these cases and the public health response efforts to reduce the risk to the population and improve awareness of baylisascariasis among health care providers and the public.

Investigation and Results

On September 4, 2024, LACDPH was notified by a physician at Children's Hospital Los Angeles of two possible cases of *B. procyonis* infection in an adolescent (patient A) and a young child (patient B). The families of both patients consented to these cases being described. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[†]

Patient A Characteristics, Treatment, and Outcome

Patient A was an adolescent boy aged 14 years who had received a previous diagnosis of autism spectrum disorder and had a history of pica. In May 2024, he was hospitalized after a week of behavioral changes, including sleepiness, decreased activity, confusion, and unsteady gait (*3*). The results of laboratory analyses of specimens collected during hospital admission indicated mild peripheral eosinophilia (14% eosinophils; >1,000 eosinophils/mL of blood). His symptoms progressively worsened, and brain magnetic resonance imaging (MRI) showed numerous enhancing lesions. Analysis of a lumbar puncture specimen revealed the presence of 15% eosinophils in the cerebrospinal fluid (CSF). The combination of the patient's symptoms, MRI findings, and especially, peripheral eosinophilia and eosinophilic meningitis prompted concern for *B. procyonis* infection by a clinician who had previously encountered a case. Ophthalmologic examination revealed a live parasitic nematode in the eye, which was treated using laser ablation (Figure 1), leading to a presumptive diagnosis of baylisascariasis.

CDC was consulted for guidance regarding testing and treatment for suspected *B. procyonis* infection. Treatment with 6 weeks of albendazole and corticosteroids was initiated immediately (*6*). CSF and serum specimens were sent to CDC for confirmatory testing by immunoblot assay using the recombinant *B. procynonis* antigen BpRAG1. Serum was weakly positive for *B. procyonis* antibodies, whereas CSF test results were negative; this pattern has been reported previously (*4*). Cross-reactivity with sera from patients with toxocariasis was not observed. The patient's signs and symptoms subsequently resolved, and he returned to his baseline neurologic status.

[†] 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.

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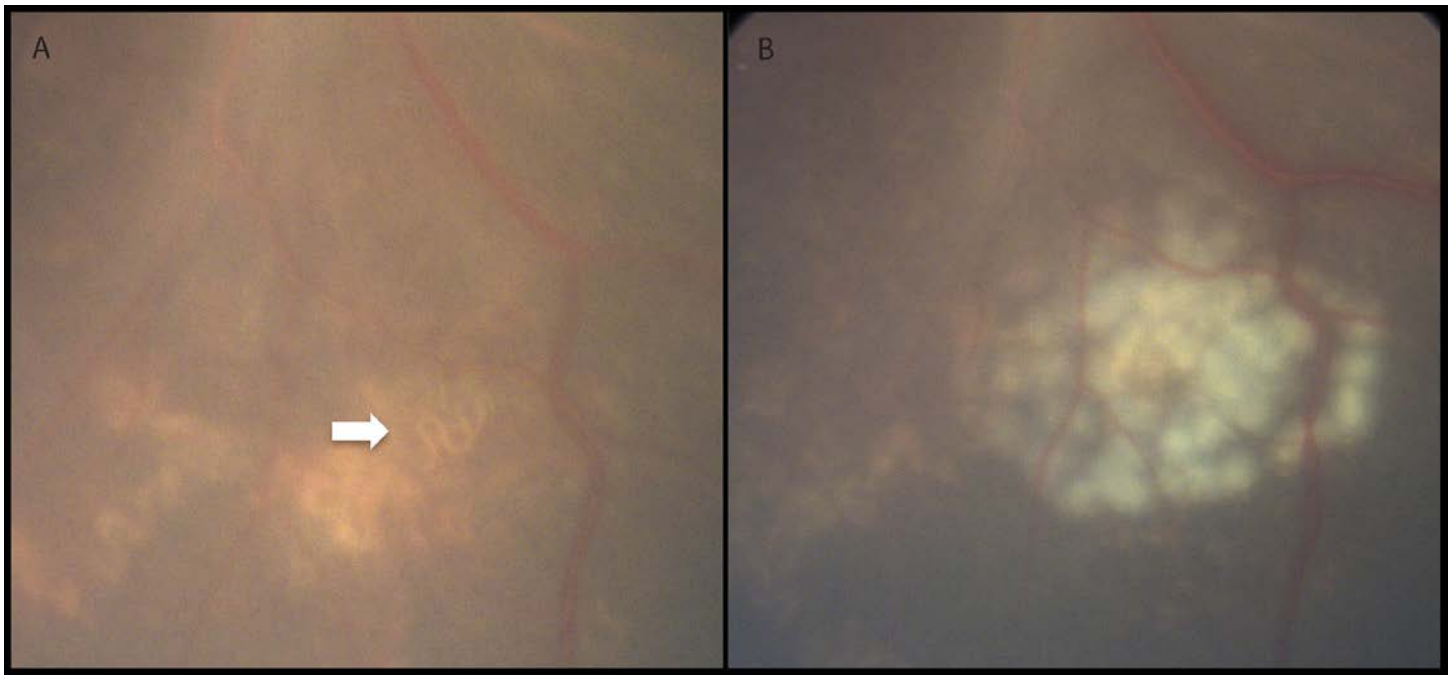
FIGURE 1. Fundus of patient A's eye, illustrating a live subretinal nematode (A), and immediately after laser ablation treatment (B) — Los Angeles County, California, 2024



Photos/Vision Center, Department of Surgery, Children's Hospital Los Angeles

Patient B Characteristics, Treatment, and Outcome

Patient B was a child aged 15 months who had been meeting all his developmental milestones. He was hospitalized in June 2024 for evaluation of encephalopathy, lethargy, generalized weakness, gait instability, and progressively increasing muscle tone. Initial laboratory testing demonstrated peripheral blood eosinophilia (53% eosinophils) and eosinophilic CSF pleocytosis (16%). Brain MRI demonstrated diffuse white matter abnormalities. The child's initial treatment occurred at two children's hospitals and included empiric treatment of suspected acute disseminated encephalomyelitis, comprising intravenous immunoglobulin, corticosteroids, the monoclonal antibody rituximab, and plasmapheresis. After 6 weeks, the patient was discharged from the hospital with a gastrostomy tube, a plan to taper the corticosteroids dosage, and scheduled outpatient follow-up appointments. Three months after symptom onset, the patient was taken to an ambulatory neuroimmunology clinic at a third hospital where he was examined by the same clinician who had treated patient A. Similar to patient A, the records indicated marked peripheral eosinophilia and eosinophilic meningitis, raising concern for baylisascariasis. Ophthalmologic evaluation revealed a live parasitic nematode, which was treated by laser ablation. The patient also was treated with 6 weeks of albendazole and corticosteroids. Testing was performed at CDC and as was observed with the first patient, serum was weakly positive for *B. procyonis* antibodies, whereas CSF test results were negative. The patient has persistent, severe neurologic sequelae, including cognitive, motor, and visual impairments.

Public Health Response

Site Visits to Residences of Patients A and B

After being notified about these cases, LACDPH immediately initiated public and veterinary health investigations at the patients' households to identify potential sources of exposure to *B. procyonis*. The family of patient A reported frequent sightings of numerous raccoons near the property and noted that neighbors regularly left food out for community cats, which can attract raccoons. A pet dog was also present at the property.[§] A raccoon latrine was identified on the sloping rooftop of the property (Figure 2) directly above the entrance to the premises, allowing feces to roll onto the landing below. Dried feces were found below the latrine on the staircase leading from the back door (Figure 2); patient A was known to have pica, and was suspected to have picked up and consumed the feces or feces-contaminated soil at this location. LACDPH recommended immediate removal of the latrine, decontamination of the area, and implementation of raccoon exclusion measures to prevent additional exposure (*7*). However, efforts to mitigate raccoon

[§] Although dogs can be definitive *B. procyonis* hosts, they shed fewer eggs than do raccoons. The dog was not tested; however, the owners were advised to administer regular deworming treatment.

latrines have been unsuccessful, and the raccoons continue to be observed around the property. Because of the ongoing risk for infection, the treating physician, in consultation with the family, elected to administer a 10-day course of albendazole prophylaxis to two of the patient's siblings (*6*), one of whom also had pica. In addition, because of the ongoing raccoon infestation despite efforts to deter the raccoons from the property, the family was making plans to move to a new residence.

A site visit to the residence of patient B revealed no evidence of raccoon activity or raccoon latrines, although raccoons were known to be present in the neighborhood. The family mentioned that the child had placed soil and bark mulch into his mouth on multiple occasions at their residence, local parks, and the beach. The family had no pets. A site visit to the child care center attended by patient B also found no evidence of raccoon activity, raccoon latrines, or sandboxes where raccoons might have defecated, and no other children were reported with similar symptoms at the facility.

Implementation of Public Awareness Campaign

In response to these two cases of baylisascariasis, LACDPH took immediate action to raise awareness regarding preventive strategies to reduce the risk for exposure. A public awareness campaign was conducted at households within an eight-block radius of patient A's residence, where raccoon feces had been found, as well as at child care centers in the wider area. A total of 476 households and 35 child care centers were contacted. Educational materials were distributed that described the disease and outlined preventive measures, including avoiding feeding wildlife and keeping open food sources inaccessible to community cats and raccoons[¶] (*7*).

LACDPH also published a press release and webpage to increase public awareness about the risks associated with *B. procyonis* infection in Los Angeles County and how to prevent exposure (*7*). A Los Angeles County Health Alert was published to help guide health care providers through the clinical presentation, the importance of early identification, diagnosis, timely treatment, and reporting of *B. procyonis* infections (*4*). Finally, an Animal Health Advisory was issued to veterinarians regarding *B. procyonis* transmission to domestic pets, particularly dogs, which can serve as definitive hosts, that also provided guidance about prevention strategies and safe removal of raccoon latrines (*8*).

Discussion

This report describes the public health response to two cases of *B. procyonis* eosinophilic meningoencephalitis in unrelated pediatric patients reported during a short period (September 2024) in Los Angeles County, California. Few cases of *B. procyonis* eosinophilic meningoencephalitis have been documented in the United States (*5*,*9*), and most of these patients have been young, male children with developmental disabilities, often with pica; however, infections have occurred in older age groups and in persons with occupational exposure (*5*). Despite its severe adverse health effects, the true incidence of *B. procyonis* infection in humans is not well understood. A recent serologic study in Santa Barbara County, California found a 7% seroprevalence in the general population (*10*), suggesting that asymptomatic or subclinical human infections are more common than previously thought; thus, asymptomatic cases might not be diagnosed.

FIGURE 2. Raccoon latrine on the sloping rooftop of patient A's home (A) and raccoon feces that fell from the rooftop onto the stairwell leading from the back door (B) — Los Angeles County, California, 2024

Photos/Los Angeles County Department of Public Health

Outcomes of *B. procyonis* infection can be severe if diagnosis and treatment are delayed, as was the case for patient B. The patient did not receive a diagnosis for approximately 3 months, resulting in severe neurologic sequelae. A clinician who had encountered a case before treating patient A suspected baylisascariasis in both patients A and B, suggesting that heightened awareness by the health care provider might have contributed to their diagnoses. This clinician's observation highlights the possibility that similar cases might not be diagnosed without improved awareness among health care providers of the possibility of *B. procyonis* infection.

Epidemiologic investigations suggested the possible exposure of patient A at his residence where a raccoon latrine was present and where he was suspected to have consumed material contaminated with raccoon feces. Additional environmental investigations would be necessary to confirm that the feces at the residence were the source of infection. Identifying a potential source of infection for patient B was not successful; however, his family reported that he regularly placed soil and

[¶] Raccoon Roundworm (*Baylisascaris* Infection) | LACDPH

other objects in his mouth in outdoor areas that might have been frequented by raccoons.

Implications for Public Health Practice

Given the severity of disease in humans, the high prevalence of *B. procyonis* infection in raccoons, and the proximity of raccoons to humans and pets, *B. procyonis* is a substantial public health concern. To prevent infection, the public should avoid contact with raccoons and their feces, not keep raccoons as pets, ensure that children or persons with developmental disabilities do not place contaminated objects or fingers into their mouths, practice good hand hygiene after outdoor activities, and safely remove raccoon latrines on properties, paying special attention to flat surfaces such as rooftops, decks, tree stumps, or unsealed attics and other areas where raccoons prefer to defecate** (*6*). Property owners should also take measures to prevent raccoon infestations, including eliminating access to sources of food and water; securing trash in tightly closed containers; closing off access to basements, attics, and crawl spaces; and clearing brush and trees away from the property and roof line to discourage raccoons from sleeping or defecating nearby. Sandboxes on properties should also be covered, if possible, when not in use. Dog owners should also prevent their pets from eating raccoon feces and accessing areas with raccoon feces because dogs can also be infected and shed eggs in their feces (*7*). Pets should be treated with a year-round parasite prevention product that contains an intestinal dewormer effective against *B. procyonis* and have fecal examinations for intestinal parasites performed at least annually by a veterinarian, according to existing guidelines.††

Improving awareness among the public is critical for reducing the risk for *B. procyonis* infection, especially given the ubiquity of raccoons in urban settings and the challenges associated with raccoon exclusion. For clinicians, education to heighten awareness and increase recognition is needed. Any patients, especially young children or persons with developmental disabilities or pica, who have progressive neurologic deterioration and high peripheral eosinophilia or eosinophilic meningoencephalitis, should be promptly evaluated. A history of exposure to raccoons or their feces is highly suggestive but not necessary. Empiric treatment of baylisascariasis with albendazole should be considered (*6*).

** Preventing Raccoon Roundworm | Raccoon Roundworm (*Baylisascaris* Infection) | CDC

†† *Baylisascaris procyonis* | Guidelines | Companion Animal Parasite Council

Summary

What is already known about this topic?

Baylisascaris procyonis, a roundworm parasite commonly found in raccoons, can cause baylisascariasis, a potentially severe disease in humans.

What is added by this report?

In 2024, two baylisascariasis cases characterized by encephalopathy, ocular larva migrans, peripheral and cerebrospinal fluid eosinophilia, and brain imaging abnormalities were diagnosed in unrelated children in Los Angeles County, California, associated with ingestion of raccoon feces and soil potentially contaminated with *B. procyonis*. A substantial delay in diagnosis for one patient led to severe neurologic sequelae.

What are the implications for public health practice?

Health care providers should suspect *B. procyonis* infection in patients with eosinophilic meningoencephalitis, especially young children or persons with developmental disabilities or pica and consider empiric treatment with albendazole. The public should avoid contact with raccoons and their feces.

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References

1. Sorvillo F, Ash LR, Berlin OGW, Yatabe J, Degiorgio C, Morse SA. *Baylisascaris procyonis*: an emerging helminthic zoonosis. Emerg Infect Dis 2002;8:355–9. PMID:11971766 https://doi.org/10.3201/eid0804.010273
2. CDC. Raccoon roundworm (*Baylisascaris* infection): about raccoon roundworm. Atlanta, GA: US Department of Health and Human Services, CDC; 2024. https://www.cdc.gov/baylisascaris/about/index.html
3. CDC. DPDx – laboratory identification of parasites of public health concern: baylisascariasis. Atlanta, GA: US Department of Health and Human Services, CDC; 2019. https://www.cdc.gov/dpdx/baylisascariasis/index.html
4. Lipton BA, Oltean HN, Capron RB, et al. *Baylisascaris procyonis* roundworm infection in child with autism spectrum disorder, Washington, USA, 2022. Emerg Infect Dis 2023;29:1232–5. PMID:37209678 https://doi.org/10.3201/eid2906.230290
5. Graeff-Teixeira C, Morassutti AL, Kazacos KR. Update on baylisascariasis, a highly pathogenic zoonotic infection. Clin Microbiol Rev 2016;29:375–99. PMID:26960940 https://doi.org/10.1128/CMR.00044-15
6. CDC. Raccoon roundworm (*Baylisascaris* infection): clinical overview of raccoon roundworm. Atlanta, GA: US Department of Health and Human Services, CDC; 2024. https://www.cdc.gov/baylisascaris/hcp/clinical-overview/index.html
7. Los Angeles County Department of Public Health. Raccoon roundworm disease (*Baylisascaris procyonis*). Los Angeles, CA: Los Angeles County Department of Public Health; 2024. http://publichealth.lacounty.gov/acd/raccoonroundworm.htm
8. Los Angeles County Department of Public Health. Animal health advisory: raccoon roundworm in Los Angeles County. Los Angeles, CA: Los Angeles County Department of Public Health; 2024. http://publichealth.lacounty.gov/vet/docs/AHAN/AHAN_RaccoonRoundwormLAC_09172024.pdf
9. Sircar AD, Abanyie F, Blumberg D, et al. Raccoon roundworm infection associated with central nervous system disease and ocular disease—six states, 2013–2015. MMWR Morb Mortal Wkly Rep 2016;65:930–3. PMID:27608169 https://doi.org/10.15585/mmwr.mm6535a2
10. Weinstein SB, Lake CM, Chastain HM, et al. Seroprevalence of *Baylisascaris procyonis* infection among humans, Santa Barbara County, California, USA, 2014–2016. Emerg Infect Dis 2017;23:1397–9. PMID:28726612 https://doi.org/10.3201/eid2308.170222

Solar Panel Installation Workers Exposed to Pesticides During Two Agricultural Applications — Michigan, August 2023 and May 2024

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Abstract

Persons who work near farmland are at risk for exposure to pesticides applied on adjoining agricultural areas. Michigan regulations allow solar panel placement on farmland and open areas near farmland. Nonagricultural workers, including construction workers installing or maintaining solar panels, working in open areas on or adjacent to farmland might be exposed to pesticides yet have little knowledge of the possible health effects. Reports to Michigan's state pesticide surveillance program from hospitals, emergency departments, the state's poison center, and emergency service companies identified two separate events, the first in August 2023 and the second in May 2024, when workers installing solar panels experienced illness after pesticide exposures. In these two events, a total of 10 solar panel installation workers reported symptoms temporally related to nearby agriculture pesticide applications. Pesticide applicator adherence to product label instructions is critical to preventing bystander exposure. Increasing awareness of the potential for pesticide exposure among nonagricultural workers near farmland might reduce risk. Employers of nonagricultural workers who are working in rural areas should be aware of agricultural activity surrounding their worksites and should consider contacting farmers to determine pesticide application schedules so that nonagricultural workers can be advised to avoid the area or wear protective equipment during application times. Local poison control centers can provide guidance on management of acute exposures.

Introduction

In Michigan, approximately 9.7 million acres (26.6%) of the state's land are devoted to farming (*1*), and a majority of the farming involves pesticide application (*2*). Michigan regulations allow solar panel placement on farmland (*3*) and open areas near farmland. In 2023, Michigan's net electricity generation from utility-scale solar power increased by 53% (*4*). Persons who perform any work on or near farmland, including those who install solar panels, are at risk for exposure to agricultural pesticides (*5*).

The approximately 25,000 persons licensed to apply pesticides in Michigan are required to pass an initial examination and obtain continuing educational credits (at least eight and ≥16 for commercial and private licensees, respectively) every 3 years (*6*). Pesticide certification licensing is not required for persons applying pesticides to their own or their employer's property, provided the pesticide is not classified as a restricted-use product* by the Environmental Protection Agency (EPA). Worker pesticide exposures are investigated by the Michigan Occupational Safety and Health Administration (MIOSHA), which regulates workplace health and safety, and the Michigan Department of Agricultural and Rural Development (MDARD), which has EPA-delegated regulatory authority for pesticides, including pesticide safety for applicators and farmworkers. This report describes two separate incidents, the first in August 2023 and the second in May 2024, when a total of 10 workers installing solar panels adjacent to agricultural land experienced illness after being exposed to pesticides.

Methods

Data Sources

An occupational pesticide exposure case is defined as an illness in a worker exposed to a known pesticide who experiences two or more signs or symptoms temporally related to the exposure in a manner plausible or consistent with the product's known toxicologic effects (*7*). Michigan Public Health Code requires Michigan medical providers, including the Michigan Poison and Drug Information Center† (poison center), emergency medical services (EMS), physicians, hospitals, and emergency departments (EDs) to report cases of pesticide exposure to the state's pesticide surveillance program. Michigan's acute pesticide–related illness and injury surveillance program is operated by the Division of Occupational and Environmental Medicine at Michigan State University as a bona fide agent of Michigan's Department of Health and Human Services. The goal of the program is to track acute pesticide exposures that occurred both at work and at home to help prevent future illness and injury.

Analysis

Workers' demographic characteristics, pesticides to which they were exposed, signs and symptoms, and clinical outcomes were evaluated and are described. This investigation was determined by both the Michigan Department of Public

* United States Environmental Protection Agency | Pesticide Worker Safety | Restricted Use Products Report

† Michigan Poison & Drug Information Center | Wayne State University

Health and the Michigan State University Institutional Review Board (IRB) to be nonresearch public health surveillance and therefore did not require IRB approval.

Results

Pesticide Exposure Event A: Miravis Neo Fungicide and Tombstone Insecticide, August 2023

Exposed workers. Event A occurred in August 2023 when eight men aged 20–69 years who were installing solar panels became symptomatic immediately after exposure to spray drift from the aerial application of a nonrestricted-use fungicide (Miravis Neo[§]; EPA registration number 100–1605) and a restricted-use insecticide (Tombstone[¶]; EPA registration number 34704–912). The exposure followed the aerial application to crops in a neighboring field by a licensed applicator. The products were applied from an airplane, an estimated 12–50 yards (11–46 m) from approximately 20–25 workers installing solar panels.

Seven of the eight cases were reported to the pesticide surveillance program by the state poison center (Table), including four cases for which the solar panel installation company's safety manager called the poison center, and three cases for which ED physicians called the poison center. Three cases were reported by hospital EDs and EMS companies, including two that had also been identified by the poison center. Hospital records were requested and reviewed by Michigan's acute pesticide surveillance program for the six cases that were not reported directly by the hospital. An occupational medicine physician reviewed the medical records. The solar panel installation company's safety manager reported the names of the pesticides to the poison center after obtaining them from the pesticide application manager, and MDARD reviewed the pesticide application records and confirmed the names of the pesticides. Six of the eight workers agreed to be interviewed by the Michigan acute pesticide surveillance program.

Symptoms and medical evaluation. The company's safety manager telephoned the poison center for medical advice 10 minutes after the exposure. The workers reported dizziness, nausea, cough, irritated eyes, mouth numbness, headache, shortness of breath, chest tightness, skin redness, rash, or irritation, and muscle weakness. All eight workers were evaluated in an ED on the day of the exposure, placed in decontamination showers, and given intravenous fluids; laboratory bloodwork, chest radiographs, and electrocardiograms were analyzed. All workers were discharged from the ED the same day with no additional treatment. One worker who experienced persistent difficulty breathing and coughing at work visited the ED again 7 days later where he received an anticholinergic through a nebulizer and was prescribed a long-acting anticholinergic inhaler and an oral steroid. Four workers were referred by their employer to an occupational medicine physician 1 month after the exposure for ongoing shortness of breath, coughing, weekly headaches, and a sore throat. Symptoms among the other four workers resolved by the time they were discharged from the ED. The workers' signs and symptoms of eye, skin, and respiratory irritation were consistent with the known toxic effects of the pesticides identified by the manufacturers.** With the exception of one worker who continued to require treatment for new-onset asthma 5 weeks after exposure, all exposed workers' symptoms were resolved by 5 weeks following the exposure. ED records of the two workers not interviewed indicated their symptoms subsided before they were discharged from the ED.

Response to Event A Pesticide Exposure

MDARD issued a citation with no monetary penalty to the applicator, stating that the Miravis Neo product had been used in a manner inconsistent with the label, which stated, "[D]o not apply at wind speeds below 3 miles per hour (mph)." Both high and low wind speeds can increase spray drift onto nontarget areas. High wind speeds, generally those above 10 mph (16.1 kph)[††] increase the spread of the application, whereas low wind speeds (<3 mph) increase potential for variable or gusting winds and can result in temperature inversions, which can cause wider dispersion of the pesticide in cold air trapped beneath warmer air. The wind speed at the time of application was recorded by the applicator as 2 mph. MIOSHA did not receive a complaint.

Pesticide Exposure Event B: Roundup PowerMAX 3 Herbicide, May 2024

Exposed workers. Event B occurred in May 2024 when an estimated eight workers installing solar panels were exposed to nonrestricted-use Roundup PowerMAX 3 herbicide[§§] (EPA registration number 524–659) that was sprayed from a tractor an estimated 5 feet (1.5 m) from the workers. Neither the solar panel installation company nor their workers were informed of the planned application before it occurred. The workers were told the name of the pesticide by their employer. It is unknown how the employer learned the name of the pesticide.

Symptoms and medical evaluation. Two male solar panel installation workers, aged 30 and 49 years, reported sore throat, irritated and watery eyes, skin rash or redness, cough, chest

[§] Syngenta | Miravis Neo fungicide | Product Label
[¶] Loveland Products | Tombstone insecticide | Product Label

** Syngenta | Miravis Neo | Safety Data Sheet; Loveland Products | Tombstone | Safety Data Sheet
†† Suggested wind speeds during application will vary by product and required application wind speeds will be stated on the product label.
[§§] Roundup PowerMAX 3 herbicide | Product Label

TABLE. Characteristics of solar panel installation workers (N = 10) who sought medical care after being exposed to agricultural pesticides during two events — Michigan, August 2023 and May 2024

Characteristic	Exposure event, no. (%)	
	Event A: Miravis Neo* fungicide and Tombstone insecticide† (n = 8) August 2023	Event B: Roundup PowerMAX 3 herbicide§ (n = 2) May 2024
Reporting source		
Poison center only	5 (63)	0 (—)
ED only	1 (13)	0 (—)
Poison center and ED	1 (13)	2 (100)
Poison center and EMS	1 (13)	0 (—)
Estimated exposed workers	20–25 (100)	8 (100)
Workers reporting illness	8 (32–40)	2 (25)
Male sex	8 (100)	2 (100)
Age group, yrs		
20–29	3 (38)	0 (—)
30–39	2 (25)	1 (50)
40–49	0 (—)	1 (50)
50–59	2 (25)	0 (—)
60–69	1 (13)	0 (—)
Reported sign or symptom		
Cough	6 (75)	1 (50)
Dizziness	5 (63)	0 (—)
Headache	5 (63)	2 (100)
Shortness of breath	5 (63)	0 (—)
Irritated or watery eyes	3 (38)	2 (100)
Nausea	3 (38)	0 (—)
Skin rash, redness, or irritation	3 (38)	2 (100)
Mouth numbness	2 (25)	0 (—)
Muscle weakness	2 (25)	1 (50)
Chest pain	1 (13)	1 (50)
Sore throat	0 (—)	2 (100)
Hospitalized	0 (—)	0 (—)

Abbreviations: ED = emergency department; EMS = emergency medical services.
* Syngenta US | Miravis Neo | Safety Data Sheet
† Loveland Products | Tombstone | Safety Data Sheet
§ Bayer Crop Science United States | Roundup PowerMAX 3 herbicide | Safety Data Sheet

pain, muscle weakness, and headache within hours of exposure (Table). One worker was evaluated in an ED on the day of exposure, was placed in a decontamination shower, and was discharged within 2 hours after his symptoms improved with no additional treatment. The second worker was evaluated in the ED after 2 days of symptoms and released and evaluated again 4 days after the exposure for persistent muscle weakness. In the ED, laboratory bloodwork was analyzed, and he was given a nonsteroidal anti-inflammatory drug for muscle pain with improvement in symptoms. Symptoms of eye, skin, and respiratory irritation reported by the exposed workers were consistent with known toxic effects of the pesticide identified by the manufacturer.¶¶ The two exposures were reported to the state surveillance program by the poison center after calls from the treating health care providers at two EDs. Telephone interviews were conducted by the Michigan acute pesticide surveillance program with both exposed workers, who reported the name of the pesticide to the ED physicians and in telephone interviews.

Response to Event B Pesticide Exposure

MIOSHA issued a citation to the installation workers' employer for the violation of not ensuring that a safety data sheet for the pesticide was made readily available to the workers within 5 days after the exposure. MIOSHA does not regulate pesticide usage and did not address that the product label specified a 4-hour restricted entry interval, during which persons should not be in the application area. MDARD did not receive a complaint.

Discussion

In Michigan, approximately 16,000 pesticide products are registered for sale and use (*8*). Pesticide applicator licensing is intended to ensure that pesticide use minimizes environmental hazards and toxicity to applicators and bystanders. Exposure to

¶¶ Bayer | Roundup PowerMAX 3 herbicide | Safety Data Sheet

pesticides can be alarming for persons who do not know what substance they were exposed to and are experiencing symptoms or have concerns about long-term health effects.

Bystanders can be exposed to restricted- and nonrestricted-use pesticides administered by licensed and nonlicensed applicators. Restricted-use pesticides have a higher potential to cause harm and are only available for purchase by persons licensed to use them. All pesticide applicators, irrespective of licensure status, must follow product label instructions and understand how to prevent off-target spray drift, a common cause of pesticide exposure contributing to acute illness (*5*). Identifying the specific pesticide product and contacting a local poison center for treatment advice assists physicians and health care providers who treat workers after an acute pesticide exposure.

Because solar panel installation and other types of nonagricultural work (e.g., county road maintenance) can occur adjacent to farmland, outreach to and education of employers, employees, and health care professionals are needed to ensure that these persons are aware of signs and symptoms of pesticide exposure. Pesticide regulating agencies and occupational health agencies perform different roles in investigating occupational exposure to pesticides. Pesticide regulating agencies such as MDARD review records and determine applicator procedures, even if the applicator is not the employer of who was exposed or reported the exposure. If the complaint is filed promptly, vegetation or clothing samples can be collected in nontarget areas and analyzed for pesticide residue to ascertain whether the spray drifted. Because proper medical management requires knowing the pesticide involved, the pesticide regulatory agency can also identify and notify exposed persons of the involved products. An investigation by the Occupational Safety and Health Administration (OSHA) or a state OSHA program such as MIOSHA will address workplace health and safety. This includes identifying whether workers such as the solar panel installation workers have the ability to determine which products they might be exposed to and whether their employer evaluated engineering and administrative controls to prevent exposure, including access to personal protective equipment. The pesticide regulatory agency investigation is not limited to safeguarding employees and covers independent contractors, owners, and nonworking persons, including children. Pesticide regulating agencies, occupational health programs, and relevant public health authorities can work together to investigate occupational pesticide exposures and provide recommendations, outreach, and education to prevent additional exposures.

Limitations

The findings in this report are subject to at least four limitations. First, knowledge of events involving nonagricultural workers' exposure to farmland-applied pesticides is limited by medical provider compliance with state reporting requirements. In event A, six of the eight workers examined in an ED were not reported by the ED as required by Michigan regulations. Second, additional events might have occurred that were not reported because the exposed workers either did not experience symptoms or did not seek medical attention. Therefore, some exposure events might not have been identified in the state's pesticide surveillance program. Third, the surveillance program is limited to the acute effects and does not address the potential of long-term chronic effects from lower pesticide exposures that do not cause acute symptoms. Finally, these results are limited to a single state and might not be generalizable to other states, although a previous report described bystander exposure in 10 other states (*5*).

Summary

What is already known about this topic?

Nonagricultural personnel working on or adjacent to farmland can be exposed to direct spray or off-target spray drift from farm-related pesticide applications.

What is added by this report?

In August 2023 and May 2024, Michigan's pesticide surveillance program identified two events involving 10 total solar panel installation workers who required medical evaluation after exposure to pesticides. One worker developed new-onset asthma; all others had no long-term sequelae.

What are the implications for public health practice?

To reduce the risk of pesticide exposure among nonagricultural employees working near farmland, employers can notify neighboring farms of their work and coordinate appropriate safety precautions. Persons applying pesticides should follow all product labeling. Local poison control centers can provide guidance regarding acute exposures.

Implications for Public Health Practice

To minimize the risk for pesticide exposure among pesticide applicators and bystanders, all applicators should read, understand, and follow all product labeling. Whether the type of application and product droplet size require an application exclusion zone defined by the EPA Worker Protection Standard should be ascertained by the applicator (*9*). In addition, ensuring adequate distance between the borders of the application and nontarget areas can help avoid spray drift and might be required by the product label. Posted application restrictions, such as a restricted entry interval that does not permit persons in the application area for specific period after application, might also apply.

Employers who work in rural areas should be aware of the farmland surrounding each project site. Because farmers are not required to apprise nonagricultural workers about pesticide

application, employers of nonagricultural workers working in rural areas should be aware of agricultural activity surrounding their worksites and should consider contacting farmers to determine pesticide application schedules so that nonagricultural workers can be advised to avoid the area or wear protective equipment during application times.

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References

1. Knudson W. Michigan State University Product Center; Food, Ag, Bio. Farmland use in Michigan. East Lansing, MI: Michigan State University Product Center; 2023. https://msu-prod-2310.dotcms.cloud/productcenter/uploads/files/landuse.pdf
2. US Department of Agriculture. National Agricultural Statistics Service. 2022 Census of agriculture. Washington, DC: US Department of Agriculture; 2024. https://www.nass.usda.gov/Publications/AgCensus/2022/index.php#full_report
3. Michigan Department of Agriculture and Rural Development. Policy for allowing commercial solar panel development on PA 116 lands. Lansing, MI: Michigan Department of Agriculture and Rural Development; 2019. https://farmlandinfo.org/wp-content/uploads/sites/2/2020/07/MDARD_Policy_on_Solar_Panel_and_PA116_Land_656927_7.pdf
4. US Energy Information Administration. State profile and energy estimates: Michigan. Washington, DC: US Energy Information Administration; 2024. https://www.eia.gov/state/seds/?sid=MI
5. Lee S-J, Mehler L, Beckman J, et al. Acute pesticide illnesses associated with off-target pesticide drift from agricultural applications: 11 states, 1998–2006. Environ Health Perspect 2011;119:1162–9. PMID:21642048 https://doi.org/10.1289/ehp.1002843
6. Michigan Department of Agriculture and Rural Development, Pesticide and Plant Pest Management Division. Michigan Department of Agriculture and Rural Development 2024 annual report. Lansing, MI: Michigan Department of Agriculture and Rural Development, Pesticide and Plant Pest Management Division; 2024. https://www.michigan.gov/mdard/-/media/Project/Websites/mdard/documents/annual-reports/2024/MDARD2024AnnualReports.pdf
7. National Institute for Occupational Safety and Health. Case definition for acute pesticide-related illness and injury cases reportable to the National Public Health Surveillance System. Washington, DC: National Institute for Occupational Safety and Health; 2012. https://www.cdc.gov/niosh/media/pdfs/casedef.pdf
8. Michigan Department of Agriculture and Rural Development. Pesticide registration. Lansing, MI: Michigan Department of Agriculture and Rural Development; 2025. Accessed April 3, 2025. https://www.michigan.gov/mdard/licensing/pesticide/pestregistration
9. United States Environmental Protection Agency. Agricultural Worker Protection Standard. Washington, DC: Environmental Protection Agency; 2025. Accessed May 29, 2025. https://www.epa.gov/pesticide-worker-safety/agricultural-worker-protection-standard-wps

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