Pesticide Illness and Injury Surveillance in Michigan 2021

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Pesticide Illness and Injury Surveillance in Michigan: 2021

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Summary

Michigan has been conducting surveillance for acute work-related pesticide illnesses and injuries since 2001. In 2006, data on non-occupational cases were added. The Public Health Code grants Michigan the authority to track work-related conditions (PA 368 of 1978, Part 56, as amended) and chemical poisoning (R325.71-R325.75). This is the seventeenth report on pesticide-related illnesses and injuries in Michigan (2001-3, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015-16, 2017-18, 2019, 2020). These 17 reports include 21 years of data.

From 2001 through 2021 there were 1,454 confirmed cases of occupational pesticide-related illnesses or injuries. Fifty-three of those confirmed cases were reported in 2021. The number of reported cases peaked in 2008. Disinfectants continued to be the cause of about half of the confirmed occupational cases (47% from 2001-2021) and were the cause of 45% of confirmed occupational cases in 2021. Many of these cases would not have occurred if disinfectant containers were properly labeled, not mixed, and used only in situations where their use was recommended.

In 2021, where activity of the exposed person was known, 20% of confirmed occupational cases were exposed to pesticides inadvertently while doing their regular work that did not involve applying pesticides. The most common contributing factor for confirmed occupational cases were excessive application and mixing incompatible products. The most common occupations were cleaning/housekeeping/janitorial and groundskeepers/lawn service, comprising 25% and 11% of the confirmed cases in 2021, respectively.

From 2006 through 2021, there were 2,887 confirmed cases of non-occupational pesticide-related illnesses or injuries. Sixty-nine of those confirmed cases were reported in 2021.

In 2021, insecticides accounted for 29% of confirmed non-occupational cases while disinfectants accounted for 17%.

Where activity of the exposed person was known, 72% of confirmed non-occupational cases were involved in applying the pesticide themselves. ‘Bystander’ exposure was also important, with 25% exposed inadvertently while doing activities not involved in the application of a pesticide.

Background

Pesticide poisoning is a potential public health threat due to widespread pesticide use. According to the U.S. Environmental Protection Agency (EPA), more than 1.1 billion pounds of conventional (non-disinfectant) pesticides were used in the United States in 2012, the last year of published data (Atwood and Paisley-Jones, 2017).

Pesticides are a category of chemicals that are used to kill or control insects, weeds, fungi, rodents, and microbes. There are over 16,000 different pesticides registered for sale in Michigan, containing over 600 different active ingredients.

The term pesticide includes insecticides, herbicides, fungicides, rodenticides, disinfectants, and various other substances used to control pests.

Evidence has linked pesticides with a variety of acute health effects such as conjunctivitis, dyspnea, headache, nausea, seizures, skin irritation, and upper respiratory tract irritation (Roberts and Reigart, 2013). The effects of chronic or long-term exposures include cancers, immune function impairments, neurological disorders, reproductive disorders, respiratory disorders, and skin disorders (Schenker et al., 2007).

Acting on concerns about acute occupational pesticide-related illness, NIOSH began collecting standardized information about acute occupational pesticide exposure from selected states in 1998 (Centers for Disease Control and Prevention (CDC), 2017) under the Sentinel Event Notification System for Occupational Risk (SENSOR) program. An analysis of 1998-99 data provided by the SENSOR states demonstrated that the surveillance system was a useful tool to assess acute pesticide-related illness and to identify associated risk factors (Calvert et al., 2004).

Agriculture is a major industry in Michigan with 52,194 farms, 80,000 farm operators and 77,000 hired workers. Hired workers include full time and migrant workers (US Department of Agriculture, 2017). There are 16,220 different pesticide products registered for sale and use in Michigan (MDARD, 2020). There are 6,700 privately certified agricultural pesticide applicators (number overlaps with farm operators/workers above), another 16,100 commercially certified applicators and 2,097 businesses licensed to apply pesticides in Michigan (MDARD, 2021).

Recognizing the extent of pesticide use in Michigan, in 2001 Michigan joined other NIOSH-funded states to institute an occupational pesticide illness and injury surveillance program. In 2006, non-occupational pesticide exposures were added to the surveillance program. In 2006, non-occupational pesticide exposures were added to the surveillance system. The surveillance data are used to:

- Identify groups at risk for pesticide-related illnesses;
- Identify clusters/outbreaks of pesticide-related illnesses;
- Detect trends;
- Identify high-risk active ingredients;
- Identify illnesses that occur even when the pesticide is used correctly; and
- Identify and refer cases to regulatory agencies for interventions.

Methods

Pesticide poisoning is reportable under the Public Health Code (Part 56 of Act 368 of 1978 as amended and R 325.71-5). These two parts of the public health code require health care providers (including Michigan's Poison Control Center), health care facilities, and employers to report to the state information about individuals (including names) with known or suspected pesticide poisoning. From 2001-2006 Michigan only conducted occupational pesticide illness and injury surveillance. Beginning in 2006, non-occupational cases were included in the surveillance system. At that time, poison control began reporting cases in which the reason for exposure was coded "Unintentional – Environmental". To fully capture all environmental exposures, beginning in 2012 reporting included the exposure reasons of "Unintentional – General", "Unintentional – Misuse", and "Unintentional – Unknown". Due to limited resources, from 2014 onward, non-occupational cases were only included in the surveillance system if care from a medical provider was obtained.

In addition to information from reports submitted under the Public Health Code, the surveillance system collects information on individuals with pesticide exposures who have been reported to the Pesticide and Plant Pest Management Division of the Michigan Department of Agriculture and Rural Development (MDARD). MDARD receives complaints about pesticide misuse and health effects and is mandated to conduct investigations to address potential violations of pesticide laws. Other data sources include coworkers and worker advocates.

The pesticide poisoning surveillance system is a case-based system. A person who has been exposed to a known pesticide and develops two or more signs or symptoms after that exposure, that could be related to the exposure based on known toxicology, is considered a confirmed case. See Appendix I for more details of the case definition. An event is the incident where the case was exposed. More than one person may be exposed at an event. Data are collected according to standardized variable definitions in a database developed for NIOSH's SENSOR-Pesticide program.

Reported occupational cases are interviewed to determine the circumstances of the reported exposure, the symptoms they experienced, the name of the pesticide, the name of the workplace where the exposure occurred, and other details about the incident. When possible, medical records are obtained to confirm and clarify the conditions reported. Non-occupational cases are not interviewed, due to resource constraints.

Reported cases are then classified based on criteria related to (1) documentation of exposure, (2) documentation of adverse health effects, and (3) evidence supporting a causal relationship between pesticide exposure and health effects. All cases are classified as either definite, probable, possible, suspicious, unlikely, insufficient information, exposed but asymptomatic, or unrelated (Appendix I). Cases classified as definite, probable, possible, or suspicious (DPPS) are considered confirmed and included in all data analyses.

Confirmed cases are evaluated regarding the severity of the health effect: low; moderate; high; or death. The severity index is based on the signs and symptoms experienced, whether medical care was sought, if a hospital stay was involved, and whether time was lost from work or daily activities (CDC, 2001).

Occupation and industry were coded using the NIOSH Industry and Occupation Computerized Coding System (NIOCCS) (NIOSH, 2012), which uses the 2002 Census Industry Codes and the 2002 Census Occupation Codes. Industry was then grouped into the NIOSH industry sectors (CDC, 2013).

Practices where workers or the public may be at risk were identified. When appropriate, referrals were made to either the Michigan Occupational Safety and Health Administration (MIOSHA) (LEO) or MDARD, which have regulatory responsibility for worker health and/or pesticide use

MIOSHA enforces state and federal workplace standards on exposure limits, education, and personal protective equipment (PPE) and performs training in safety and health in construction and general industry. MDARD enforces state and federal legal requirements for the sale and use of pesticides, including label violations and instances of human exposure and the federal EPA's Worker Protection Standard, which includes requirements to protect agricultural workers from adverse health effects of pesticides.

In addition, NIOSH was provided information about high priority events, both occupational and non-occupational. The criteria for defining high priority events were:

a. events that result in a hospitalization or death;
b. events that involve four or more ill individuals;
c. events that occur despite use according to the pesticide label; or
d. events that indicate the presence of a recurrent problem at a particular workplace.

NIOSH referred cases to the EPA as needed, identified clusters across states, and identified the need for national level interventions.

Finally, if appropriate, Michigan surveillance staff provided educational consultations to reported individuals and/or their employers about reducing hazards related to pesticide exposures.

Results

Section I. All Reports

From 2001 through 2021, 4,341 individuals with reported pesticide exposure and related illnesses and/or injuries met the criteria for confirmed cases. Approximately one-third of those cases were work-related (Table 1).

Table 1: Case Confirmation by Work-Relatedness, 2001-2021

Status	Occupational	Non-Occupational	Total
Definite Case	130	53	183
Probable Case	314	585	899
Possible Case	957	2144	3101
Suspicious Case	53	105	158
Total	**1454**	**2887**	**4341**

Males and females of all ages were exposed to pesticides (Table 2).

Table 2: Confirmed Cases by Age Group & Gender, 2001-2021 and 2021 separately

	Cumulative			2021		
Age Groups	**Female**	**Male**	**Unknown**	**Female**	**Male**	**Unknown**
<1 (Infants)	9	15	1	0	0	0
01-02 (Toddlers)	51	70	0	0	1	0
03-05 (Preschool)	37	60	0	0	0	0
06-11 (Child)	95	63	0	1	0	0
12-17 (Youth)	87	93	1	1	2	0
18-64 (Adult)	1669	1529	0	60	45	0
65+ (Senior)	169	165	0	5	7	0
Unknown age	110	74	43	0	0	0
Total	**2227**	**2069**	**45**	**67**	**55**	**0**

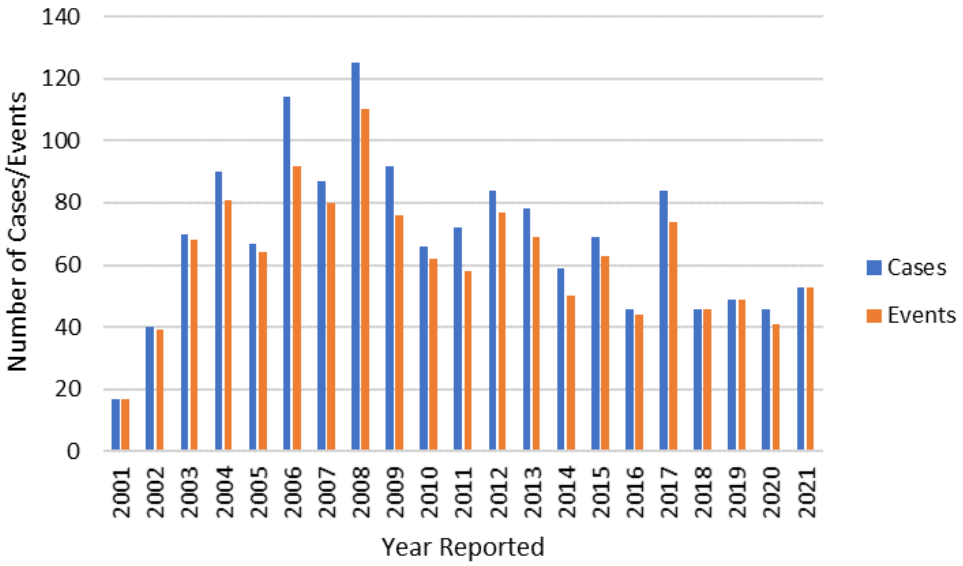
A male in his 30's was working for a landscaping company while he was mixing Round Up weed killer using a Gatorade bottle to dilute it into another container. He set the Gatorade bottle filled with roundup down and thought he was grabbing his drink, but mistakenly grabbed the Gatorade bottle instead. He took a big sip of Roundup and immediately developed throat irritation and vomited. He went to the emergency room for medical treatment where he stayed two nights.

A male in his 30s walked through his home shortly after releasing an insecticide fogger. He developed shortness of breath, a cough, and wheezing. He sought advice from poison control and then sought treatment in the emergency department.

Section II. Occupational Pesticide Illnesses and Injuries

This section describes 1,454 confirmed occupational cases. In 2021, there were 53 cases from 53 events (Figure 1).

Figure 1: Confirmed Occupational Cases and Events by Year



People

Occupational pesticide cases occur in people of a wide variety of ages. In 2021, women (55%) were more likely to be confirmed occupational cases than men (45%) (Table 3).

Table 3: Confirmed Occupational Cases by Age Group & Gender, 2001-2021 & 2021 Separately

	Cumulative			2021		
Age Groups	**Female**	**Male**	**Unknown**	**Female**	**Male**	**Unknown**
00-09	0	0	0	0	0	0
10-19	50	74	0	1	0	0
20-29	183	240	0	8	6	0
30-39	126	154	0	4	4	0
40-49	117	147	0	2	8	0
50-59	111	96	0	8	4	0
60-69	25	28	0	6	2	0
70-79	2	6	0	0	0	0
80+	0	0	0	0	0	0
Unknown	40	42	13	0	0	0
Total	**654**	**787**	**13**	**29**	**24**	**0**

In 2021, race was unknown for 70% of cases, when race was known most cases (86%) were white and 14% were black. In 2021, ethnicity was known in 66% of the cases. When known, most (91%) were not Hispanic while 9% were Hispanic (Table 4).

Table 4: Confirmed Occupational Cases by Race and Ethnicity, 2001-2021 and 2021 Separately

	Cumulative			2021		
Race	**Hispanic**	**Not Hispanic**	**Unknown**	**Hispanic**	**Not Hispanic**	**Unknown**
Indigenous American	0	6	0	0	0	0
Asian/Pacific Islander	0	3	3	0	0	0
Black	0	60	33	0	5	0
White	26	515	124	2	27	3
Mixed	3	24	2	0	0	0
Other	6	0	1	0	0	0
Unknown	59	0	589	1	0	15
Total	**94**	**608**	**752**	**3**	**32**	**18**

Confirmed cases were identified in a wide variety of occupations. In 2021, the most common occupations were cleaners/housekeepers/janitors and groundskeepers/lawn service with thirteen and six cases, respectively (Table 5). Sales and office, farming, and healthcare each had four cases. These five categories accounted for just over three fourths (79%) of cases where the occupation was known.

Table 5: Confirmed Occupational Cases by Occupation, 2001-2021 and 2021 Separately

	Cumulative		2021	
Occupation	**Count**	**Percent**	**Count**	**Percent**
Cleaners/Housekeepers/Janitors	171	11.8%	13	24.5%
Sales and Office	90	6.2%	4	7.5%
Production and Transportation	89	6.1%	2	3.8%
Farming	88	6.1%	4	7.5%
Management, Professional, and Related	81	5.6%	1	1.9%
Healthcare	75	5.2%	4	7.5%
Food Preparation and Service	68	4.7%	0	0.0%
Pest Control Operators	62	4.3%	1	1.9%
Groundskeepers/Lawn Service	65	4.5%	6	11.3%
Protective Services	32	2.2%	0	0.0%
Personal Care and Service	29	2.0%	2	3.8%
Construction	27	1.9%	1	1.9%
Installation, Maintenance, and Repair	15	1.0%	1	1.9%
Military	2	0.1%	0	0.0%
Unknown	560	38.5%	14	26.4%
Total	**1454**	**100.0%**	**53**	**100.0%**

Confirmed cases were identified in a wide variety of industries. 'Services' includes 'accommodation and food services' as well as 'building services' and was the most common sector in 2021, followed by healthcare & social assistance (Table 6).

Table 6: Confirmed Occupational Cases by Industry Sector, 2001-2021 and 2021 Separately

	Cumulative		2021	
Industry Sector	**Count**	**Percent**	**Count**	**Percent**
Agriculture, Forestry, Fishing	157	10.8%	2	3.8%
Construction	41	2.8%	1	1.9%
Healthcare & Social Assistance	207	14.2%	13	24.5%
Manufacturing	83	5.7%	5	9.4%
Public Safety	27	1.9%	1	1.9%
Services (excluding Public Safety)	553	38.0%	14	26.4%
Transportation, Warehousing, Utilities	42	2.9%	2	3.8%
Wholesale & Retail Trade	110	7.6%	1	1.9%
Unknown	234	16.1%	14	26.4%
Total	**1454**	**100.0%**	**53**	**100.0%**

Most (57%) cases in 2021 were of moderate severity, 42% were low severity, and 2% were high severity.

A female in her 50s was working for a cleaning company when she ingested a mouthful of a mixture of three different disinfectants used for COVID-19 cleaning. The disinfectants were in a juice bottle kept in the refrigerator. To rinse her mouth, she drank from a second bottle, and swallowed a mouthful of hydrogen peroxide. She developed tachycardia, redness on the roof of her mouth, burning in her chest, and emesis. She sought care in the emergency department who consulted poison control.

Events

In 2021, when the person's activity at the time of exposure was known, most exposures (78%) occurred when a person was involved with pesticide application, such as mixing or applying a pesticide, transport or disposal of a pesticide, or some combination of these activities. Another 10 exposures (20%) happened to bystanders who were doing routine work, not related to the application.

In 2021, the most common pesticide exposure was to disinfectants (45%), followed by insecticides (8%) (Table 7). Some products contain more than one type of pesticide and some exposures involved more than one product, so the number of types listed is greater than the number of exposures.

A male in his 30s was spraying an herbicide on apples while working on a farm. He developed shortness of breath and nausea and went to the emergency department. He was diagnosed as having acute chemical pneumonitis. He was prescribed a bronchodilator and an oral steroid.

Table 7: Confirmed Occupational Cases by Pesticide Type, 2001- 2021 and 2021 Separately

	Cumulative		2021	
Pesticide Type	**Count**	**Percent**	**Count**	**Percent**
Disinfectant	740	47.0%	27	45.0%
Insecticide	378	24.0%	5	8.3%
Herbicide	197	12.5%	2	3.3%
Fungicide	54	3.4%	1	1.7%
Multiple types	61	3.9%	2	3.3%
Other	86	5.5%	2	3.3%
Unknown	59	3.7%	21	35.0%
Total	**1575**	**100.0%**	**60**	**100.0%**

Identification of factors contributing to the exposure assists with the development of prevention strategies. Up to five contributing factors were coded for each case. In 2021, excessive application and mixing incompatible products were the most common contributing factors for occupational pesticide cases (Table 8).

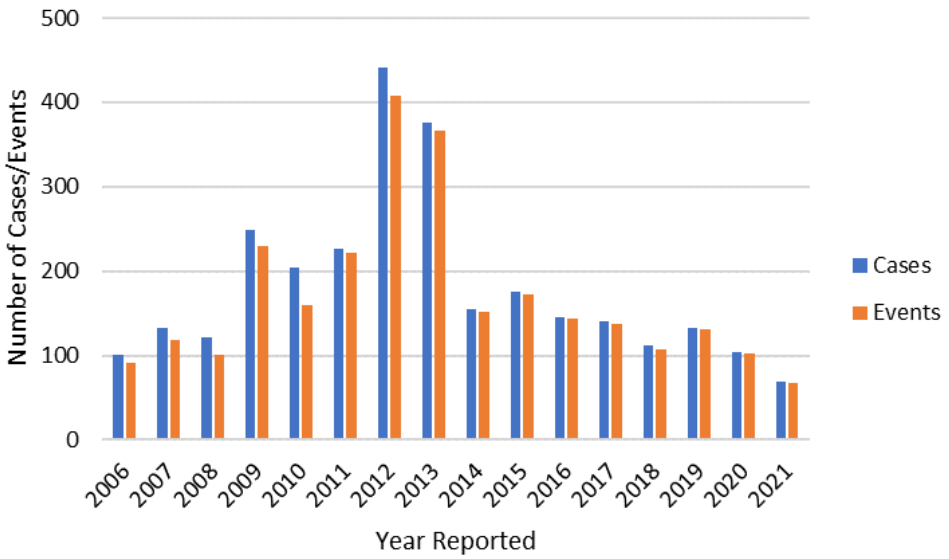
Table 8: Contributing Factors in Confirmed Occupational Cases, 2001-2021 & 2021 Separately

	Cumulative		2021	
Contributing Factor	**Count**	**Percent**	**Count**	**Percent**
Spill / Splash of liquid or dust (not equipment failure)	401	21.3%	8	12.9%
Mixing incompatible products	199	10.6%	9	14.5%
Label violations not otherwise specified	130	6.9%	3	4.8%
No label violation identified but person still exposed / ill	116	6.2%	6	9.7%
Required eye protection not worn or inadequate	112	6.0%	3	4.8%
Application equipment failure	106	5.6%	0	0.0%
Decontamination not adequate or timely	106	5.6%	1	1.6%
Excessive application	98	5.2%	9	14.5%
Drift contributory factors	82	4.4%	1	1.6%
People were in the treated area during application	47	2.5%	1	1.6%
Required gloves not worn or inadequate	47	2.5%	6	9.7%
Notification / posting lacking or ineffective	42	2.2%	0	0.0%
Applicator not properly trained or supervised	41	2.2%	2	3.2%
Structure inadequately ventilated before re-entry	29	1.5%	0	0.0%
Early re-entry	27	1.4%	0	0.0%
Within reach of child or other improper storage	26	1.4%	3	4.8%
Required respirator not worn or inadequate	23	1.2%	5	8.1%
Other required PPE not worn or inadequate	12	0.6%	2	3.2%
Intentional harm	1	0.1%	1	1.6%
Illegal pesticide used / Illegal dumping	1	0.1%	0	0.0%
Other	61	3.2%	2	3.2%
Unknown	172	9.2%	0	0.0%
Total	**1879**	**100.0%**	**62**	**100.0%**

Section III. Non-occupational Pesticide Illnesses and Injuries

To provide a more complete characterization of the impact of pesticide use in Michigan, the pesticide surveillance program began collecting information about non-occupational exposures in 2006. The same case definition and report sources were used for occupational and non-occupational cases. In 2012, three additional non-occupational exposure categories from poison control were added, but in 2014, because of limited resources, data entry was limited to cases who visited a health care provider, excluding non-occupational cases whose only medical contact was to call the poison control center. There were 69 confirmed cases from 68 events entered into the database in 2021 (Figure 2). There were another 122 confirmed non-occupational cases who had called the poison control center but had not seen a provider or had seen a provider but experienced no exposure related sign/symptom and/or the pesticide was unknown and were therefore not entered in the database. Suicide attempts using pesticides are also excluded from this report. There is no follow-up to collect additional information from non-occupational cases so some cases may have been missed because we did not know there was more than one sign or symptom or because we did not identify the pesticide (both required for non-occupational case confirmation).

Figure 2: Confirmed Non-occupational Cases and Events by Year



A female in her 40s mixed an alcohol-based toilet bowl cleaner with a sodium hypochlorite-based toilet bowl cleaner when cleaning a bathroom at her friend's house. She inhaled fumes and developed difficulty breathing. She called 911 who sought the advice of poison control. She was then transferred to the emergency department via EMS.

A male in his 30s was using a pressure sprayer wand to spray an insecticide on his lawn when the hose broke causing the insecticide to spray on his abdomen and leg. He became hot and flushed and developed nausea, shortness of breath, and diarrhea. He sought medical attention in the emergency department where they consulted with poison control.

People

Non-occupational pesticide cases occurred among people of all ages. In 2021, when sex was known, females (55%) were more likely than males (45%) to have a non-occupational pesticide exposure (Table 9). Race and ethnicity data were rarely available for non-occupational cases.

Table 9: Confirmed Non-occupational Cases by Age Group & Gender, 2006-2021 & 2021 Separately

	Cumulative			2021		
Age Groups	**Female**	**Male**	**Unknown**	**Female**	**Male**	**Unknown**
<1 (Infants)	9	15	1	0	0	0
01-02 (Toddlers)	51	70	0	0	1	0
03-05 (Preschool)	37	60	0	0	0	0
06-11 (Child)	95	63	0	1	0	0
12-17 (Youth)	76	71	1	1	2	0
18-64 (Adult)	1072	822	0	33	21	0
65+ (Senior)	163	149	0	3	7	0
Unknown age	70	32	30	0	0	0
Total	**1573**	**1282**	**32**	**38**	**31**	**0**

Most (64%) non-occupational cases in 2021 were of moderate severity, 23 (33%) were moderate severity, and one (2%) was of high severity.

A 1-year-old male infant ingested an unknown amount of a disinfectant while left unattended. He had 4 episodes of emesis and developed a cough. His mother brought him to the emergency department where they consulted with poison control.

Events

In 2021, when the person's activity at the time of exposure was known, most exposures (72%) occurred when a person was involved with a pesticide application, such as mixing or applying a pesticide, transport or disposal of a pesticide, or some combination of these activities. Another 25% happened to bystanders and 1% happened during application of a pesticide to a person (themselves or another).

A female in her 40s mixed an alcohol-based toilet bowl cleaner with a sodium hypochlorite-based toilet bowl cleaner when cleaning a bathroom at her friend's house. She inhaled fumes and developed difficulty breathing. She called 911 who sought the advice of poison control. She was then transferred to the emergency department via EMS.

In 2021, the most common pesticide exposure was to insecticides and disinfectants (29% and 17%, respectively) (Table 10). Some products contain more than one type of pesticide and some exposures involved more than one product, so the number of types listed is greater than the number of exposures.

Table 10: Confirmed Non-occupational Cases by Pesticide Type, 2006-2021 & 2021 Separately

	Cumulative		2021	
Pesticide Type	**Count**	**Percent**	**Count**	**Percent**
Disinfectant	1148	37.8%	13	17.3%
Insecticide	978	32.2%	22	29.3%
Insect Repellent	216	7.1%	0	0.0%
Herbicide	207	6.8%	8	10.7%
Rodenticide	31	1.0%	1	1.3%
Fungicide	28	0.9%	2	2.7%
Multiple	209	6.9%	12	16.0%
Other	77	2.5%	0	0.0%
Unknown	147	4.8%	17	22.7%
Total	**3041**	**100.0%**	**75**	**100.0%**

Identification of factors contributing to the exposure assists with the development of prevention strategies. Up to five contributing factors were coded for each case. In 2020, people being in the treated area during application was the most common contributing factor for non-occupational pesticide cases, followed by no label violation identified but the person was still exposed and developed symptoms (Table 11).

Table 11: Contributing Factors in Confirmed Non-occupational Cases, 2006-2021 & 2021

	Cumulative		2021	
Contributing Factor	**Count**	**Percent**	**Count**	**Percent**
Mixing incompatible products	478	14.6%	10	12.8%
Label violations not otherwise specified	438	13.3%	7	9.0%
Spill / Splash of liquid or dust (not equipment failure)	319	9.7%	5	6.4%
Excessive application	285	8.7%	8	10.3%
No label violation identified but person still exposed / ill	249	7.6%	11	14.1%
Within reach of child or other improper storage	231	7.0%	2	2.6%
People were in the treated area during application	158	4.8%	15	19.2%
Drift contributory factors	112	3.4%	3	3.8%
Decontamination not adequate or timely	103	3.1%	0	0.0%
Structure inadequately ventilated before re-entry	102	3.1%	6	7.7%
Early re-entry	96	2.9%	7	9.0%
Notification / Posting lacking or ineffective	60	1.8%	0	0.0%
Application equipment failure	51	1.6%	1	1.3%
Required eye protection not worn or inadequate	18	0.5%	0	0.0%
Required gloves not worn or inadequate	17	0.5%	0	0.0%
Applicator not properly trained or supervised	11	0.3%	1	1.3%
Other required PPE not worn or inadequate	8	0.2%	0	0.0%
Intentional harm	3	0.1%	0	0.0%
Required respirator not worn or inadequate	2	0.1%	0	0.0%
Illegal pesticide used / illegal dumping	2	0.1%	0	0.0%
Other	90	2.7%	1	1.3%
Unknown	448	13.7%	0	0.0%
Total	**3281**	**100.0%**	**77**	**100.0%**

Outreach, Education, and Prevention Activities

Publications, Presentations, and Other Outreach Activities
The Occupational Pesticide Illness and Injury Program used a variety of avenues to provide information about the program and pesticide safety to stakeholders and the general public. In 2021:

- The pesticide surveillance program coordinator provided case narratives each quarter to the MDARD Pesticide Advisory Committee (PAC) each quarter. Dr. Rosenman is also a member of the PAC.

- The MDHHS Pesticide Information webpage provided links to all previous annual reports, a pesticide education booklet, "What You Need to Know about Pesticides and Your Health", several fact sheets, and over 150 other sites with information about pesticides and their safe use.

- A press release about Poison Prevention Week was released in March by MDHHS.

- A press release about recreational water safety was released before Memorial Day by MDHHS.

- No exposures were reported to NIOSH from cases reported in 2021.

- MDARD and MIOSHA both conducted investigations on one case of a disinfectant used in a fogger in 2021.

  An auto manufacturer contracted with a cleaning company to provide cleaning and disinfection. The cleaning company used the disinfectant in a fogger, which was not an allowable usage on the disinfectant label, and fogged areas where workers who were positive for COVID-19 had worked. The cleaning company ceased using the disinfectant in a fogger after MIOSHA conducted their inspection. The active ingredients of the disinfectant used were Didecyl dimethyl ammonium chloride (10.14%) and n-Alkyl (C14 50%, C12 40%, C16 10%) dimethyl benzyl ammonium chloride (6.76%).

  MIOSHA did not issue any citations pertaining to the fogger/respirator use as it was outside of their scope and referred the case to MDARD . The MDARD investigation was ongoing at the time this annual report was prepared.

Discussion

Surveillance Data

There were 53 confirmed occupational cases reported in 2021. This is consistent with the range from previous years of surveillance (17-127), and the average (70). The number of confirmed occupational cases peaked in 2008.

There were 69 confirmed non-occupational cases in 2021. This is lower than the range from previous years of surveillance (102-447) and lower than the average number of cases for those years (180). There was an increase in non-occupational cases in 2012 and 2013 because the coding of cases we reviewed from the poison control center exposure reasons was expanded to capture all non-occupational cases. The number went down again in 2014 because, due to the limited resources of the pesticide surveillance program, only non-occupational cases who sought additional medical care beyond the poison control center were entered into the database.

The number and proportion of confirmed cases related to disinfectant exposures remained high and continued to be an area of ongoing concern. In 2021, 45% of occupational cases and 17% of non-occupational cases were exposed to a disinfectant. It is likely that some of these cases would not have occurred if the disinfectants had been used only in situations where their use was recommended (Rosenman et al., 2020). Because of the current COVID-19 pandemic, the use of disinfectants is widespread. The calls to the Michigan poison control center about adverse health effects from disinfectants have increased since the onset of the COVID-19 pandemic (Rosenman et al., 2021). Ongoing education is needed to provide guidance about how to use disinfectants safely when their use is recommended.

When looking at factors contributing to pesticide exposures in 2021, excessive application and mixing incompatible products were the most common factors for confirmed occupational cases (15% each), followed by spill/splash of liquid or dust (13%). The most common factors contributing to non-occupational exposures was people being in the treated area during application (19%), followed by no label violation identified but the person was still exposed and experienced symptoms (14%) and mixing incompatible products (13%). Better education and labeling might help to reduce the number of exposures.

Many confirmed cases in 2021 were “bystanders”, i.e., engaged in work or living activities not related to the pesticide application (20% of occupational cases and 25% of non-occupational cases). Better education on safe pesticide application is needed to prevent inadvertent exposures, as well as the exposures to applicators.

Interventions

Pesticide surveillance staff continued to work with other state and federal agencies. Pesticide program surveillance staff also worked to improve pesticide education for individuals,

employers, health care providers, and other stakeholder groups through the distribution of fact sheets and presentations.

Challenges to Surveillance

Pesticide poisoning is a complex condition for surveillance. The potential for pesticides to harm people depends in part on the dose (length of exposure and chemical concentration) and the route of entry into the body. Pesticides have a range of toxicity, from low toxicity (no signal word required by EPA) through slightly toxic (EPA signal word: Caution), moderately toxic (EPA signal word: Warning) and most toxic (EPA signal word: Danger). Pesticide products are often mixtures including one or more active ingredients, as well as other "inert" ingredients that have no effect on the target pest but may have adverse human health effects. Depending on the chemicals involved, pesticides can have short- and long-term adverse health effects on different organ systems, including the skin, gastrointestinal, respiratory, nervous, and reproductive systems.

The problem of identifying pesticide-related illness for public health surveillance begins with difficulties in recognition and diagnosis, because the signs and symptoms of pesticide toxicity can be the same as those that occur with common conditions such as allergies, acute conjunctivitis, or acute gastrointestinal illness. Health care providers receive limited education in the recognition and diagnosis of the toxic effects of pesticides and the role of pesticides may not be considered when evaluating patients with signs/symptoms that can be caused by common medical conditions. Besides problems in recognition by health care providers, patients may not seek medical care (Calvert, 2004). Migrant workers face additional barriers such as language difficulties, lack of access to care, and fear of job loss or deportation if they are not legal residents (Pardo et al., 2017). Finally, even when diagnosed, pesticide-related illnesses and injuries may not be reported due reluctance on the part of workers and their health care providers to involve state agencies, the busy work schedules of providers or lack of knowledge of the public health code reporting requirements (Calvert et al., 2009).

Continued outreach is needed to educate health care providers on the importance of recognizing and reporting pesticide illnesses and injuries. In 2021, 53% of confirmed occupational cases and 55% of the non-occupational cases were reported by the State's poison control center.

Like data from other occupational injury and illness surveillance systems, (Azaroff et al., 2002) the Michigan occupational pesticide surveillance data are probably a significant undercount of the true number of work-related pesticide poisoning cases in Michigan. A 2004 study done in the State of Washington found that the primary barrier for migrant farm workers in seeking health care was economic. Workers could not afford to take time off to seek medical care and were afraid that if they did, they might lose their jobs. That study also found that only 20-30% of pesticide-related illnesses among farm workers who filed a workers' compensation claim were given a diagnosis code that indicated pesticide poisoning (Washington Department of Health, 2004). Michigan's workers' compensation data identify poisonings as a group but are not specific enough to capture pesticide exposures.

This surveillance system continues to face challenges due to the time lag between the occurrence and the reporting of the incident from hospital and MDARD reports. This presents difficulties in following up with reported cases because of worker mobility, especially among seasonal farm workers. PCC reports are received promptly from Michigan's poison control center, but do not always contain enough information to allow contact with the exposed individual. Lack of information for follow-up often results in a case classification of "insufficient information" and an inability to refer cases to regulatory agencies in a timely manner.

Notwithstanding these limitations, the Michigan pesticide surveillance system is receiving and investigating reports of occupational pesticide illness and injury, including follow-up prevention activities. We are heartened by the downward trend in this decade and will continue to conduct surveillance to monitor this trend.

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Additional Resources

MDHHS Division of Environmental Health pesticide information: www.michigan.gov/mdch-toxics

NIOSH occupational pesticide poisoning surveillance system: www.cdc.gov/niosh/topics/pesticides/

Pesticide-Related Illness and Injury Surveillance: A How-To Guide for State-Based Programs DHHS (NIOSH) publication number 2006-102. October 2005: http://www.cdc.gov/niosh/docs/2006-102/

MDARD Pesticide and Plant Pest Management Division (for information on licensing and registration for pesticide application businesses, credentials for certified technicians, and laws and regulations for pesticide application): https://www.michigan.gov/mdard/0,4610,7-125-1572_2875-8324--,00.html

Michigan State University's Pesticide Education Program: www.pested.msu.edu

Information on pesticide products registered for use in Michigan: http://npirspublic.ceris.purdue.edu/state/

EPA Pesticide Product Label System: http://oaspub.epa.gov/apex/pesticides/f?p=PPLS:1

Extoxnet Pesticide Information Profiles: http://extoxnet.orst.edu/pips/ghindex.html

Information on the federal Worker Protection Standard (worker exposure to pesticides in agriculture): https://www.epa.gov/pesticide-worker-safety

Recognition and Management of Pesticide Poisonings, Sixth Edition: http://www2.epa.gov/pesticide-worker-safety/recognition-and-management-pesticide-poisonings

To report occupational pesticide exposures in Michigan: https://oem.msu.edu/index.php/2-uncategorised/28-disease-report-form

Appendix I

Case Definition for Acute Pesticide-Related Illness and Injury Cases Reportable to the National Public Health Surveillance System

Clinical Description
This surveillance case definition refers to any acute adverse health effect resulting from exposure to a pesticide product (defined under the Federal Insecticide Fungicide and Rodenticide Act [FIFRA]1) including health effects due to an unpleasant odor, injury from explosion of a product, inhalation of smoke from a burning product, and allergic reaction. Because public health agencies seek to limit all adverse effects from regulated pesticides, notification is needed even when the responsible ingredient is not the active ingredient.

A case is characterized by an acute onset of symptoms that are dependent on the formulation of the pesticide product and involve one or more of the following:

- Systemic signs or symptoms (including respiratory, gastrointestinal, allergic and neurological signs/symptoms)
- Dermatologic lesions
- Ocular lesions

This case definition and classification system is designed to be flexible permitting classification of pesticide-related illnesses from all classes of pesticides. Consensus case definitions for specific classes of chemicals may be developed in the future.

A case will be classified as occupational if exposure occurs while at work (this includes working for compensation; working in a family business, including a family farm; working for pay at home; and, working as a volunteer Emergency Medical Technician (EMT), firefighter, or law enforcement officer). All other cases will be classified as non-occupational. All cases involving suicide or attempted suicide will be classified as non-occupational.

A case is reportable to the national surveillance system when there is (see the Classification Criteria section for a more detailed description of these criteria):

- Documentation of new adverse health effects that are temporally-related to a documented pesticide exposure; AND
- Consistent evidence of a causal relationship between pesticide and the health effects based on known toxicology of the pesticide from commonly available toxicology texts, government publication, information supplied by the manufacturer, or two or more case series or positive epidemiologic investigations, OR
- Insufficient toxicologic information available to determine whether a causal relationship exists between the pesticide exposure and the health effects

Laboratory criteria for diagnosis
If available, the following laboratory data can confirm exposure to a pesticide:

- Biological tests for the presence of, or toxic response to, the pesticide and/or its metabolite (in blood, urine, etc.);
    - Measurement of the pesticide and/or its metabolite(s) in the biological specimen
    - Measurement of a biochemical response to the pesticide in a biological specimen (e.g., cholinesterase levels)
- Environmental tests for the pesticide (e.g., foliage residue, analysis of suspect liquid);
- Pesticide detection on clothing or equipment used by the case subject.

Classification Criteria

Reports received and investigated by state programs are scored on the three criteria provided below (criteria A, B and C). Scores are either 1, 2, 3, or 4, and are assigned based on all available evidence. The classification matrix follows the criteria section (Table 1). The matrix provides the case classification categories and the criteria scores needed to place the case into a specific category. Definite, probable, possible and suspicious cases (see the classification matrix) are reportable to the national surveillance system. Additional classification categories are provided for states that choose to track reports that do not fit the criteria for national reporting. Appendix 2 of "Pesticide-Related Illness and Injury Surveillance: A How-To Guide for State-Based Programs" lists the characteristic signs and symptoms for several pesticide active ingredients and classes of pesticides.

A) *Documentation of Pesticide Exposure*

1) Laboratory, clinical or environmental evidence corroborate exposure (at least one of the following must be satisfied to receive a score of A1):
    a) analytical results from foliage residue, clothing residue, air, soil, water or biologic samples;
    b) observation of residue and/or contamination (including damage to plant material from herbicides) by a trained professional [Note: a trained professional may be a plant pathologist, agricultural inspector, agricultural extension agent, industrial hygienist or any other licensed or academically trained specialist with expertise in plant pathology and/or environmental effects of pesticides. A licensed pesticide applicator not directly involved with the application may also be considered a trained professional.];
    c) biologic evidence of exposure (e.g., response to administration of an antidote such as 2-PAM, Vitamin K1, Vitamin E oil preparation, or repeated doses of atropine);
    d) documentation by a licensed health care professional of a characteristic eye injury or dermatologic effects at the site of direct exposure to a pesticide product known to produce such effects (these findings must be sufficient to satisfy criteria B.1 under documentation of adverse health effect);
    e) clinical description by a licensed health care professional of two or more postexposure health effects (at least one of which is a sign) characteristic for the pesticide as provided in Appendix 2.

2) Evidence of exposure based solely upon written or verbal report (at least one of the following must be satisfied to receive a score of A2"):
   a) report by case;
   b) report by witness;
   c) written records of application;
   d) observation of residue and/or contamination (including damage to plant material from herbicides) by other than a trained professional;
   e) other evidence suggesting that an exposure occurred.

3) Strong evidence that no pesticide exposure occurred.

4) Insufficient data.

B) <u>Documentation of Adverse Health Effect</u>

1) Two or more new post-exposure abnormal signs and/or test/laboratory findings reported by a licensed health care professional.

2) At least one of the following must be satisfied to receive a score of B2:
   a) Two or more new post-exposure abnormal symptoms were reported. When new post-exposure signs and test/laboratory findings are insufficient to satisfy a B1 score, they can be used in lieu of symptoms toward satisfying a B2 score.
   b) Any new illness or exacerbation of pre-existing illness diagnosed by a licensed physician, but information on signs, symptoms and/or test findings are not available or insufficient for a B1 or B2a score.

3) No new post-exposure abnormal signs, symptoms, or test/laboratory findings were reported.

4) Insufficient data (includes having only one new post-exposure abnormal sign, symptom, or test/laboratory finding).

C) <u>Evidence Supporting a Causal Relationship Between Pesticide Exposure and Health Effects</u>

1) Where the findings documented under the Health Effects criteria (criteria B) are:
   a) characteristic for the pesticide as provided in Appendix 2, and the temporal relationship between exposure and health effects is plausible (the pesticide refers to the one classified under criteria A), and/or;
   b) consistent with an exposure-health effect relationship based upon the known toxicology (i.e., exposure dose, symptoms and temporal relationship) of the putative agent (i.e., the agent classified under criteria A) from commonly available toxicology texts, government publications, information supplied by the manufacturer, or two or more case series or positive epidemiologic studies published in the peer-reviewed literature;

2) Evidence of exposure-health effect relationship is not present. This may be because the exposure dose was insufficient to produce the observed health effects. Alternatively, a temporal relationship does not exist (i.e., health effects preceded the exposure or occurred too long after exposure). Finally, it may be because the constellation of health effects is not consistent based upon the known toxicology of the putative agent from information in 25 commonly available toxicology texts, government publications, information supplied by the manufacturer, or the peer-reviewed literature;

3) Definite evidence of non-pesticide causal agent;

4) Insufficient toxicologic information is available to determine causal relationship between exposure and health effects. (This includes circumstances where minimal human health effects data is available, or where there are less than two published case series or positive epidemiologic studies linking health effects to the particular pesticide product/ingredient or class of pesticides.)

Case Classification Matrix:

Classification Categories[1]											
Classification Criteria	Definite Case	Probable Case		Possible Case	Suspicious Case	Unlikely Case	Insufficient Information		Asymptomatic[2]	Unrelated[3]	
A. Exposure	1	1	2	2	1 or 2	1 or 2	4	-	-	3	
B. Health Effects	1	2	1	2	1 or 2	1 or 2	-	4	3	-	
C. Causal Relationship	1	1	1	1	4	2	-	-	-	-	3

[1] Only reports meeting case classifications of Definite, Probable, Possible and Suspicious are reportable to the National Public Health Surveillance system. Additional classification categories are provided for states that choose to track the reports that do not fit the national reporting criteria.

[2] The matrix does not indicate whether asymptomatic individuals were exposed to pesticides although some states may choose to track the level of evidence of exposure for asymptomatic individuals.

[3] Unrelated = Illness determined to be caused by a condition other than pesticide exposure, as indicated by a >3' in the evidence of >Exposure= or >Causal Relationship= classification criteria.

Appendix II

Case Narratives, 2021 Confirmed Occupational Cases

Below are descriptions of the confirmed occupational cases reported in 2021. The narratives are organized by pesticide type and occupation. They include a description of the signs and symptoms that resulted from the exposure and medical care received. Where known, age range, gender, industry, and occupation are included. In addition, more specific information about the product such as the signal word for acute toxicity assigned by the EPA is provided when known. The signal word is assigned based on the highest hazard of all possible routes of exposure. “Caution” means the product is slightly toxic if eaten, absorbed through the skin, or can cause slight eye or skin irritation. “Warning” means the product is moderately toxic if eaten, absorbed through the skin, or can cause moderate eye or skin irritation. “Danger” means the product is highly toxic, is corrosive, or causes severe burning to the eye or skin that can result in irreversible damage.

Insecticides/Insect Repellents/Insect Growth Regulators

Agriculture

MI05640 – A male farmer in his 50's sprayed his field with an insecticide. When he was rinsing the empty jug on his pesticide applicator rig, the insecticide splashed in his eyes. His eyes became red and irritated. He was not wearing any PPE. He sought medical attention from a doctor's office who called poison control.

MI05693 – A male in his 30s was working at a marijuana processing facility when he experienced a new onset seizure. He works with bifenthrin at the facility and has been "exposed", but "not often". He experienced a seizure at work and sought medical attention in the emergency department where they consulted poison control.

MI05700 – A male agronomist in his 40s was working at a potato farm when he stepped in a puddle weeks after an insecticide was applied to the field by a coworker. His right foot began to burn and developed blisters. Both feet developed redness. Two days after the exposure he sought medical attention at a doctor's office where they consulted with poison control.

MI05711 – A male in his 30s was working for a marijuana grow manufacturing company when he filled a bucket with an insecticide. When he put the bucket down, the insecticide sloshed into his face. He developed ocular redness and blurry vision. He sought medical attention in the emergency department where they contacted poison control.

Landscaping

MI05621 – A male in his 20s was working for a landscaping company and using an insecticide when he got it on his skin and in his eye. He developed irritated skin and a superficial corneal abrasion and went to urgent care where they called poison control.

Pest Control

MI05590 – A male in his 40s was working as a pest control operator for an exterminating service. He was new to the job and found an insecticide in his work truck. He believed a co-worker was trying to intentionally harm him. He developed light headedness, a cough, and throat irritation. He called poison control.

Miscellaneous/unknown

MI05512 – A female in her 20s was working as a manager at a truck and storage unit rental service. She was mixing an insecticide to spray in the storage units and got it on her hands. She touched her face and developed skin irritation. She went to the emergency department where they consulted with poison control.

MI05642 – A male in his 20's who worked for a gutter install company sprayed an insecticide to remove wasps from the gutter area of the house. The insecticide was sprayed into his face, which became painful. He developed a burning sensation and visual disturbances. He called poison control, who encouraged him to seek medical attention in the emergency department. He did not go to the emergency department.

MI05658 – A female in her 20s was dermally exposed to pyrethrin at work. There is no information as to what she was doing when exposed, where she works, or what her duties were at work. She developed a small blister where she was exposed and sought advice from poison control.

MI05688 – A male firefighter in his 20s returned to the station from a call to a house that was infested with bed bugs. He thought he had bugs on his pants from the house and sprayed his clothing with an insecticide. He thought he was developing redness on his skin and sought advice from poison control. The redness cleared and he had no other symptoms.

MI05692 – A self-employed female home care aide in her 60s sprayed an outdoor insecticide inside a client's house. She developed a cough, chest tightness, and throat irritation. She sought medical attention in the emergency department where they consulted poison control.

MI05699 – A male in his 50s was pump spraying an insecticide at work when the insecticide was sprayed into his face and mouth. He developed nausea, emesis, and difficulty breathing. Two days after the exposure he sought medical attention in the emergency department who consulted with poison control.

MI05710 – A female in her 50s was exposed to an insecticide intermittently over 3 months while at her workplace. She developed bronchitis and pneumonia with recurrent symptoms. She sought advice from poison control.

<u>Herbicides</u>

Agriculture

MI05587 – A male in his 30s was spraying an herbicide on apples while working on a farm. He developed shortness of breath and nausea and went to the emergency department. He was

diagnosed as having acute chemical pneumonitis. He was prescribed a bronchodilator and an oral steroid.

MI05605 – A male in his 40s was working maintenance at a marijuana manufacturer. He was grinding the trash which contained used jugs of herbicide and inhaled the fumes. He developed a cough and shortness of breath and went to the emergency department. They now are required to wear respirators when grinding the trash.

Landscaping

MI05617 – A male in his 40s was working as a landscaper when he was using an herbicide with phosphoric acid. It splashed on his face. He developed a small burn on his chin and called poison control.

MI05631 – A male in his 60's, who owned a landscaping company was downwind from an application of an herbicide containing Glyphosate. The applicator was adjacent to the house where he was landscaping. He had dermal and inhalation exposure. He developed throat irritation and called poison control.

MI05651 – A male in his 30s worked for a landscaping company when he opened an herbicide container and the herbicide sprayed into his face. He developed nausea and vomiting and sought care in the emergency department who then consulted with poison control.

MI05660 – A male in his 30s was applying herbicides to a lawn while at work and began to develop chest pain, abdominal pain, light headedness, nausea, vomiting, diaphoresis, shortness of breath, and tingling in his hands. He sought medical attention from EMS who transferred him to the emergency department.

Miscellaneous/unknown

MI05607 – A male in his 20s was working as a ground sprayer and was spraying an herbicide. He developed a headache and called poison control.

Disinfectants

Agriculture

MI05491 – A male in his 60s was working as a maintenance engineer at an apple orchard. He was cleaning the dunk tanks that process the apples. The dunk tanks have an automatic disinfectant release that wasn't working properly. He inhaled the fumes from the disinfectant and developed shortness of breath and a cough. He went to the emergency department and was diagnosed as having a chemical inhalation injury.

Cleaner/housekeeper/janitor/custodian

MI05589 – A male in his 40s was working as a commercial cleaner in construction. To clean mold, he used a disinfectant in an enclosed space while wearing a respirator. He developed shortness of breath, a cough, and wheezing. He went to the emergency department and was admitted to the hospital for three nights.

MI05593 – A female in her 50s was working as a cleaner and was cleaning a basement with a disinfectant. She developed shortness of breath, a cough, and upper respiratory irritation and went to the emergency department. She was diagnosed as having chemical pneumonitis.

MI05667 – A female in her 50s was working for a cleaning company when she ingested a mouthful of a mixture of three different disinfectants used for COVID-19 cleaning. The disinfectants were in a juice bottle kept in the refrigerator. To rinse her mouth, she drank from a second bottle, and swallowed a mouthful of hydrogen peroxide. She developed tachycardia, redness on the roof of her mouth, burning in her chest, and emesis. She sought care in the emergency department who consulted with poison control.

MI05685 – A female in her 20s was working for a cleaning company when she was exposed to undiluted disinfectants. She did not know the chemicals were not diluted because they were stored in a wall pump. She developed shortness of breath, chest tightness, wheezing, and a cough. She sought medical attention in the emergency department.

MI05705 – A female in her 60s was working for a commercial cleaning company when she was exposed to a disinfectant used in a fogger. The fogger was used in areas where workers who were found positive for COVID-19 may have been. Her first exposure was in April 2020. She was exposed daily and a year and a half later she developed fatigue, a cough, shortness of breath, and chest tightness. She sought medical attention in the emergency department. She continues to be on sick leave. This case was referred to MDARD.

MI05709 – A male in his 20s was working in housekeeping for a hotel when he mixed a chlorine-based laundry detergent with bleach. He developed a shortness of breath and a cough. EMS treated him on site.

Healthcare

MI05588 – A female in her 50s was working in a nursing home when someone sprayed a disinfectant. She developed shortness of breath and chest pain and went to the emergency department. She was diagnosed as having an allergic reaction secondary to inhaled cleaning agent. She was prescribed an oral steroid.

MI05609 – A female in her 50s was working in a hospital and using a disinfectant cleaner. The cleaner splashed in her eye, and she developed a corneal abrasion and eye irritation. A doctor at the hospital called poison control.

MI05641 – A male in his 30's was working as an environmental service worker at a hospital. After he cleaned an operating room, he moved an empty box of disinfectant and did not realize residue of the chemical was on the box. His hands developed an itching and burning sensation, dryness, and turned white in color. He sought medical attention in the occupational health department in the hospital where he worked and occupational health consulted poison control.

MI05662 – A female in her 30s was working at a group home when a coworker mixed bleach and chlorine. She and another coworker breathed the fumes, and she developed a cough and

difficulty breathing. She sought advice from poison control who recommended evaluation in the emergency department, where she was subsequently treated.

MI05676 – A female in her 60s was working as a receptionist for a hospital when the janitor started the disinfectant fogger not knowing she was still in the building. She developed shortness of breath and a dry cough. About a month later, someone sprayed disinfectant odor neutralizer spray and she again developed shortness of breath and a dry cough. She sought medical attention in the emergency department of the hospital where she worked.

MI05696 – A female in her 50s was working in a senior living facility when she entered a patient's room that had just been cleaned with bleach. The initial, unconfirmed, suspicion was that bleach was in the toilet with urine present. She inhaled fumes and experienced an episode of syncope. She was transferred via EMS from work to the emergency department.

MI05698 – A female in her 20s was cleaning at work in a group living facility when she was exposed to fumes from a mixture of bleach and toilet bowl cleaner. She was exposed for about 30 minutes and developed a cough, shortness of breath, and nausea. She sought medical attention in the emergency department.

MI05704 – A female in her teens was working as a patient care technician for a dialysis clinic when she was mopping a biohazard room with diluted bleach. She began experiencing dizziness, nauseousness, chest pain, and difficulty breathing. She sought medical attention in the emergency department.

Office and sales

MI05606 – A female in her 60s was working as a business manager in a church. The church hired a cleaning company to clean due to COVID-19. They used a disinfectant which she inhaled. She developed a cough, chest tightness, and shortness of breath and went to the emergency department. She was diagnosed as having chemical pneumonia. The cleaning company now uses a different disinfectant.

MI05611 – A female in her 30s was working at a hair salon and was cleaning. She mixed two incompatible disinfectants, producing chloramine gas. She developed a cough and throat irritation. She went to the emergency department.

MI05618 – A female in her 20s was working at a marijuana dispensary and was cleaning with a rubbing alcohol-based disinfectant. She inhaled the fumes and developed throat irritation and shortness of breath and called poison control. She also recently had COVID-19 and has had ongoing breathing issues.

MI05619 – A female in her 20s was cleaning at work and mixed water and a bleach-based disinfectant in a bucket. Bleach splashed in her eye, and she developed eye irritation and a corneal abrasion. She went to the emergency department where they called poison control.

MI05674 – A female in her 30s was working as an administrator at a seasonal campground when she was in the shower and a janitor came into the bathroom to clean and mixed bleach and

ammonia. She developed a cough, chest tightness, shortness of breath, and a burning sensation in her eyes. EMS was called and transferred her to the emergency department where poison control was consulted.

Miscellaneous/unknown

MI05585 – A female in her 30s was doing routine work when she was exposed to a bleach and water disinfectant mixture. She developed a cough, shortness of breath, nausea, and vomiting. She went to the emergency department where they consulted with poison control. She was diagnosed as having an inhalation injury.

MI05586 – A male in his 60s was using a disinfectant at work when it got on his hands. He developed burns and blisters. He went to the emergency department where they consulted with poison control.

MI05591 – A male in his 50s was doing routine work when a water line broke and splashed him in the face and under his safety glasses. The water in the pipe had a disinfectant mixed with the water. He developed redness on his right side of his face and right eye. He called poison control.

MI05592 – A male in his 40s was working in a warehouse when he spilled a disinfectant on his leg. He did not decontaminate after this exposure and kept working. He later developed a burning sensation and itching and went to the emergency department.

MI05610 – A female in her 20s was at work using a disinfectant cleaner. She sprayed the disinfectant on the air conditioner and inhaled the fumes. She developed a cough and went to the emergency department where they consulted with poison control.

MI05612 – A male in his 40s was working in a jail when he was exposed to the fumes of a chemical disinfectant. He developed shortness of breath, a cough, a headache, lung irritation, and eye irritation. He went to the emergency department.

MI05616 – A female in her 40s was using disinfectants at work when she mixed bleach and an ammonia-based toilet bowl cleaner, producing chlorine gas. She developed a cough and her husband called poison control. She has a history of asthma and COPD.

MI05632 – A male maintenance worker in his 30's was working for a school district. He picked up the wrong bottle and swallowed a small amount of disinfectant cleaner. He developed minor throat irritation and called poison control.

MI05633 – A female in her 20's was cleaning at work with four different disinfectants including bleach-based, alcohol-based, and ammonium chloride-based disinfectants. She did not mix chemicals but used them separately. She was not wearing gloves and was exposed dermally while using the disinfectants. She developed stinging and burning to her fingers and some of the skin sloughed off. She sought medical attention in the ED and the ED called poison control.

MI05661 – A female in her 20s mixed water and bleach for cleaning at work and inhaled the fumes. She began coughing and had an episode of emesis. She sought medical attention in the emergency department at the requirement of her employer.

MI05668 – A female in her 50s was working for a power plant when she was using bleach mixed with water to clean surfaces. She inhaled fumes from the bleach water mixture and began feeling lightheaded and lost peripheral vision. EMS transported her from work to the emergency department where she sought medical attention.

MI05669 – A male in his 40s was getting floor cleaning chemicals from the supply closet of a steel manufacturer where he worked. He bumped a shelf and chemicals fell into a bucket, mixing toilet bowl cleaner, bleach, and an ammonium chloride-based disinfectant. He inhaled fumes of this mixture and developed difficulty breathing. EMS treated him on site, but he refused further treatment and was released against medical advice.

MI05675 – A male in his 20s was working in the construction and landscaping industry cleaning a fence. He thought he had rinsed all the bleach out of a bucket and used the same bucket to hold muriatic acid. He developed wheezing, a cough, shortness of breath, and began feeling lightheaded. He sought medical attention in the emergency department who consulted poison control.

MI05684 – A female in her 20s was using disinfectants while working for a car detailing company. She developed a cough and shortness of breath. She was not wearing any PPE. She sought medical attention in the emergency department.

MI05686 – A male in his 50s was working on a freighter when he was exposed to the fumes of a mix of bleach and delimer. He developed shortness of breath, wheezing, a cough, chest tightness, and began feeling dizzy. He was treated on site by EMS and sought medical attention in the emergency department.

MI05691 – A female in her 40s mistakenly took two sips of a bathroom disinfectant cleaner while at work. The cleaner was stored in a water bottle by a coworker. She had a self-induced episode of emesis and developed throat pain and chest pain. She sought medical attention in the emergency department where they consulted poison control.

MI05697 – A female in her 40s was exposed to bleach fumes while cleaning for over two hours. She took multiple breaks and had the windows open and used fans. She developed itchy and irritated eyes, a scratchy throat, and shortness of breath. She sought medical attention in the emergency department.

MI05712 – A male in his 30s was working for a plastics manufacturing company and was splashed on his arms and boots while pouring a disinfectant into large vats. When he was removing his boots later that day, his left leg and foot were red, and he had a rash. The next morning his leg and foot developed blisters and began itching. He sought medical attention in the emergency department.

MI05714 – A female in her 40s was working for a carnival and amusement company when she mistook a disinfectant for her soda and ingested three mouthfuls of the disinfectant. She did not develop any symptoms. Her supervisor contacted poison control for advice.

Fungicide

Agriculture

MI05687 – A male in his 40s was applying a fungicide at a potato farm where he worked when he developed a rash to his left arm and foot. The next day he developed blistering and burning. He was wearing full PPE, but the chemical came in contact with his skin. He sought medical attention in the emergency department who consulted with poison control.

Miscellaneous/unknown

MI05608 – A male in his 20s was at work when he got a fungicide on his hands. He developed skin irritation and pallor and called poison control.