Pesticide Illness and Injury Surveillance in Michigan 2020

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Pesticide Illness and Injury Surveillance in Michigan: 2020

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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 sixteenth 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). These 16 reports include 20 years of data.

From 2001 through 2020 there were 1,358 confirmed cases of occupational pesticide-related illnesses or injuries. Forty-seven of those confirmed cases were reported in 2020. The number of reported cases peaked in 2008. Disinfectants continued to be the cause of about half of the confirmed occupational cases (49% from 2001-2020) and were the cause of 56% of confirmed occupational cases in 2020. A number of these cases would not have occurred if disinfectants were used only in situations where their use was recommended.

In 2020, where activity of the exposed person was known, 24% 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 was a spill or splash of liquid or dust. The most common occupations were farming, healthcare, and cleaning/housekeeping/janitorial, each comprising 13% of the confirmed cases in 2020.

From 2006 through 2020, there were 2,712 confirmed cases of non-occupational pesticide-related illnesses or injuries. One hundred thirty of those confirmed cases were reported in 2020.

In 2020, insecticides accounted for 26% of confirmed non-occupational cases while disinfectants accounted for 22%.

Where activity of the exposed person was known, 59% of confirmed non-occupational cases were involved in applying the pesticide themselves. ‘Bystander’ exposure was also important, with 41% 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 882 active ingredients in 15,171 different pesticide products registered for sale and use in Michigan (MDARD, 2019). There are 6,700 privately certified agricultural pesticide applicators (number overlaps with farm operators/workers above), another 16,100 commercially certified applicators in 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 2020, 4,300 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, 2001-2020

Status	Occupational	Non-Occupational	Total
Definite Case	131	65	196
Probable Case	314	620	934
Possible Case	941	2142	3083
Suspicious Case	20	67	87
Total	**1406**	**2894**	**4300**

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

Table 2: Confirmed Cases by Age Group & Gender, 2001-2020 and 2020 separately

	Cumulative			2020		
Age Groups	**Female**	**Male**	**Unknown**	**Female**	**Male**	**Unknown**
<1 (Infants)	9	15	1	2	1	0
01-02 (Toddlers)	51	69	0	1	2	0
03-05 (Preschool)	37	61	0	0	3	0
06-11 (Child)	94	63	1	2	1	0
12-17 (Youth)	89	94	1	0	2	0
18-64 (Adult)	1637	1526	0	57	55	0
65+ (Senior)	167	159	1	10	14	0
Unknown age	110	74	43	0	0	0
Total	**2194**	**2061**	**45**	**72**	**78**	**0**

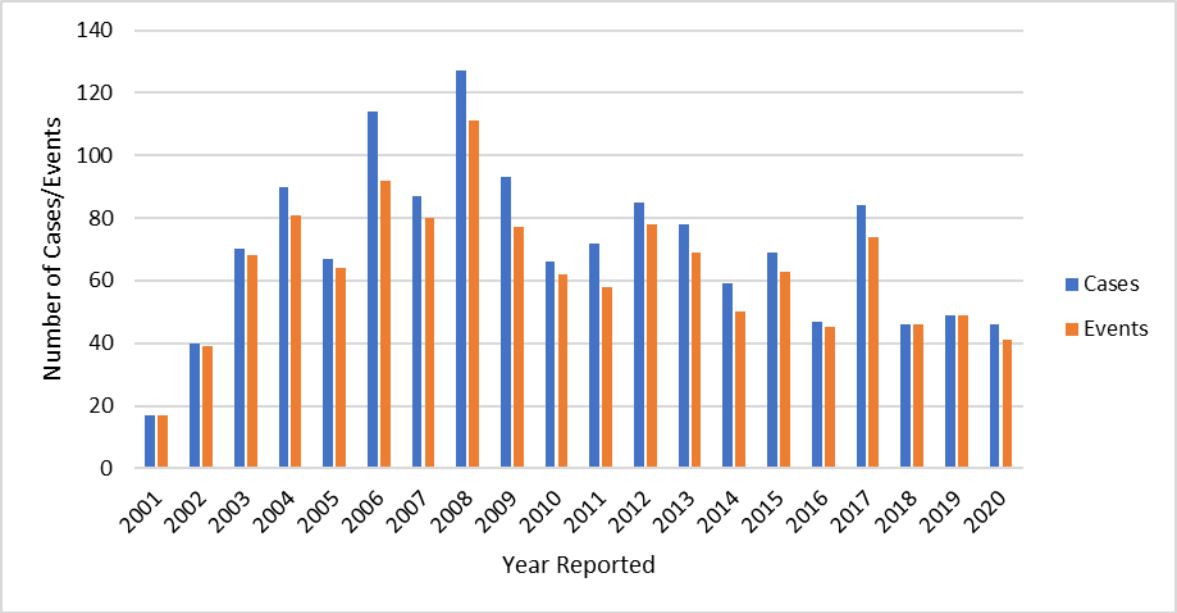
A female in her 40s was cleaning the bathroom at work and mixed bleach with another cleaning product. She inhaled the fumes and developed a cough, shortness of breath, and a sore throat. She called poison control and then sought medical treatment in the emergency department.

A male in his 20s was using Sevin dust in his yard. He developed nausea, diarrhea, and abdominal pain and vomited. He sought medical attention in the emergency department.

Section II. Occupational Pesticide Illnesses and Injuries

This section describes 1,406 confirmed occupational cases. In 2020, there were 46 cases from 41 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 2020, women (60%) were more likely to be confirmed occupational cases than men (40%) (Table 3).

Table 3: Confirmed Occupational Cases by Age Group & Gender, 2001-2020 & 2020 Separately

	Cumulative			2020		
Age Groups	**Female**	**Male**	**Unknown**	**Female**	**Male**	**Unknown**
00-09	0	0	0	0	0	0
10-19	49	74	0	2	2	0
20-29	175	235	0	4	10	0
30-39	122	151	0	5	5	0
40-49	116	140	0	2	5	0
50-59	103	93	0	3	6	0
60-69	19	26	0	1	1	0
70-79	2	6	0	0	0	0
80+	0	0	0	0	0	0
Unknown	40	42	13	0	0	0
Total	**626**	**767**	**13**	**17**	**29**	**0**

In 2020, race was unknown for 65% of cases, when race was known most cases (69%) were white, while 25% were black, and 6% were classified as “other”. In 2020, ethnicity was unknown in 67% of the cases. When known, most (67%) were not Hispanic while 33% were Hispanic (Table 4).

Table 4: Confirmed Occupational Cases by Race and Ethnicity, 2001-2020 and 2020 Separately

	Cumulative			2020		
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	55	33	0	3	1
White	24	491	122	3	7	1
Mixed	3	24	2	0	0	0
Other	6	0	1	1	0	0
Unknown	58	0	575	1	0	29
Total	**91**	**579**	**736**	**5**	**10**	**31**

Confirmed cases were identified in a wide variety of occupations. In 2020, the most common occupations were cleaners/housekeepers/janitors and groundskeepers/lawn service with seven and five cases, respectively (Table 5). Production and transportation, farming, and food preparation and service each had four cases. These five categories accounted for just under two thirds (71%) of cases where the occupation was known.

Table 5: Confirmed Occupational Cases by Occupation, 2001-2020 and 2020 Separately

	Cumulative		2020	
Occupation	Count	Percent	Count	Percent
Cleaners/Housekeepers/Janitors	158	11.2%	7	15.2%
Sales and Office	87	6.2%	2	4.3%
Production and Transportation	87	6.2%	4	8.7%
Farming	86	6.1%	4	8.7%
Management, Professional, and Related	81	5.8%	1	2.2%
Healthcare	71	5.0%	2	4.3%
Food Preparation and Service	68	4.8%	4	8.7%
Pest Control Operators	61	4.3%	2	4.3%
Groundskeepers/Lawn Service	59	4.2%	5	10.9%
Protective Services	32	2.3%	0	0.0%
Personal Care and Service	27	1.9%	0	0.0%
Construction	26	1.8%	3	6.5%
Installation, Maintenance, and Repair	14	1.0%	0	0.0%
Military	2	0.1%	0	0.0%
Unknown	547	38.9%	12	26.1%
Total	**1406**	**100.0%**	**46**	**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 2020, followed by construction (Table 6).

Table 6: Confirmed Occupational Cases by Industry Sector, 2001-2020 and 2020 Separately

	Cumulative		2020	
Industry Sector	**Count**	**Percent**	**Count**	**Percent**
Agriculture, Forestry, Fishing	155	11.0%	1	2.2%
Construction	41	2.9%	3	6.5%
Healthcare & Social Assistance	194	13.8%	1	2.2%
Manufacturing	78	5.5%	0	0.0%
Public Safety	26	1.8%	2	4.3%
Services (excluding Public Safety)	542	38.5%	9	19.6%
Transportation, Warehousing, Utilities	40	2.8%	0	0.0%
Wholesale & Retail Trade	109	7.8%	2	4.3%
Unknown	221	15.7%	28	60.9%
Total	**1406**	**100.0%**	**46**	**100.0%**

Most (78%) cases in 2020 were of low severity, 22% were moderate severity, and 0% were high severity.

A female in her 60s had an allergic reaction at work from the cleaning chemicals used in the office. There were many different chemicals used during this time because of COVID-19. She developed shortness of breath, skin irritation, and nausea. She sought medical treatment in the emergency department.

Events

In 2020, when the person's activity at the time of exposure was known, most exposures (59%) 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 16 exposures (35%) happened to bystanders who were doing routine work, not related to the application.

In 2020, the most common pesticide exposure was to insecticides and disinfectants (20% each), followed by herbicides (10%) (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 40's was working on a farm where he was spraying an insecticide. He was wearing a respirator. When he was done working, he began having symptoms of shortness of breath, throat irritation, and a rash. He went to the hospital for medical assistance where they diagnosed him with having acute chemical pneumonitis.

Table 7: Confirmed Occupational Cases by Pesticide Type, 2001- 2020 and 2020 Separately

	Cumulative		2020	
Pesticide Type	**Count**	**Percent**	**Count**	**Percent**
Disinfectant	715	47.0%	10	19.6%
Insecticide	376	24.7%	10	19.6%
Herbicide	195	12.8%	5	9.8%
Fungicide	55	3.6%	1	2.0%
Multiple types	59	3.9%	5	9.8%
Other	84	5.5%	1	2.0%
Unknown	38	2.5%	19	37.2%
Total	**1522**	**100.0%**	**51**	**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, spills and splashes were the most common contributing factor for occupational pesticide cases, followed by mixing incompatible products (Table 8).

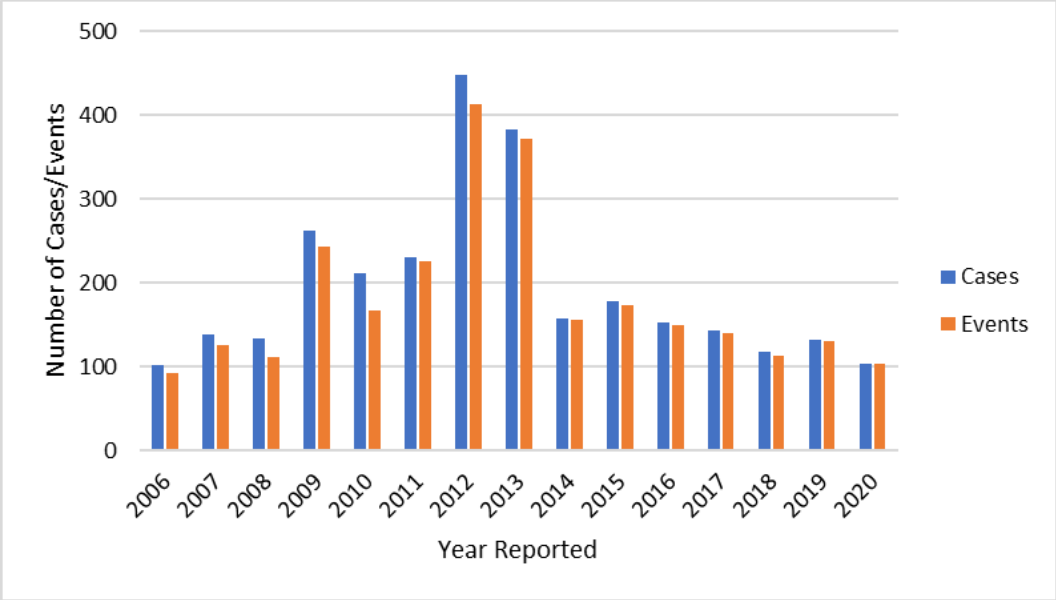
Table 8: Contributing Factors in Confirmed Occupational Cases, 2001-2020 & 2020 Separately

	Cumulative		2020	
Contributing Factor	**Count**	**Percent**	**Count**	**Percent**
Spill / Splash of liquid or dust (not equipment failure)	393	21.6%	3	5.1%
Mixing incompatible products	190	10.4%	11	18.6%
Label violations not otherwise specified	127	7.0%	14	23.7%
No label violation identified but person still exposed / ill	110	6.0%	5	8.5%
Required eye protection not worn or inadequate	109	6.0%	0	0.0%
Application equipment failure	106	5.8%	2	3.4%
Decontamination not adequate or timely	105	5.8%	0	0.0%
Excessive application	89	4.9%	7	11.9%
Drift contributory factors	81	4.4%	3	5.1%
People were in the treated area during application	46	2.5%	2	3.4%
Notification / posting lacking or ineffective	42	2.3%	3	5.1%
Required gloves not worn or inadequate	41	2.3%	0	0.0%
Applicator not properly trained or supervised	39	2.1%	0	0.0%
Structure inadequately ventilated before re-entry	29	1.6%	5	8.5%
Early re-entry	27	1.5%	3	5.1%
Within reach of child or other improper storage	23	1.3%	0	0.0%
Required respirator not worn or inadequate	18	1.0%	0	0.0%
Other required PPE not worn or inadequate	10	0.5%	1	1.7%
Intentional harm	4	0.2%	0	0.0%
Illegal pesticide used / Illegal dumping	1	0.1%	0	0.0%
Other	60	3.3%	0	0.0%
Unknown	172	9.4%	0	0.0%
Total	**1822**	**100.0%**	**59**	**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 104 confirmed cases from 103 events entered into the database in 2020 (Figure 2). There were another 119 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 male in his 40s was applying Hot Shot in a poorly ventilated area of his home. He inhaled the fumes and developed a headache, dizziness, a cough, tachycardia, and had an episode of emesis. He sought medical attention in the emergency department.

A female in her 60s was cleaning her home with a mixture of bleach and ammonia. She developed a cough, shortness of breath, and excessive tears in her eyes. She sought medical attention in the emergency department where she was diagnosed with chemical pneumonitis.

People

Non-occupational pesticide cases occurred among people of all ages. In 2020, when sex was known, females (53%) were more likely than males (47%) 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, 2006-2020 & 2020 Separately

	Cumulative			2020		
Age Groups	**Female**	**Male**	**Unknown**	**Female**	**Male**	**Unknown**
<1 (Infants)	9	15	1	2	1	0
01-02 (Toddlers)	51	69	0	1	2	0
03-05 (Preschool)	37	61	0	0	3	0
06-11 (Child)	94	63	0	2	1	0
12-17 (Youth)	78	72	1	0	1	0
18-64 (Adult)	1066	839	0	40	28	0
65+ (Senior)	163	143	0	10	13	0
Unknown age	70	32	30	0	0	0
Total	**1568**	**1294**	**32**	**55**	**49**	**0**

Most (57%) cases in 2020 were of low severity, 43 (41%) were moderate severity, and two (2%) were of high severity.

A 4-year-old boy sprayed himself in the face with Lysol disinfecting spray. He developed excessive tearing and his eyes were irritated and painful. His caretaker brought him to the emergency room for assessment where they consulted with poison control.

Events

In 2020, when the person's activity at the time of exposure was known, most exposures (66%) 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 17% happened to bystanders and 15% happened during application of a pesticide to a person (themselves or another).

A female in her 60s spilled a can of carbaryl dust in her home and vacuumed up the spill. She developed dizziness, a cough, shortness of breath, diarrhea, nausea, abdominal pain, and emesis. She sought medical attention in the emergency department.

In 2020, the most common pesticide exposure was to insecticides and disinfectants (23% and 13%, 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, 2006-2020 & 2020 Separately

	Cumulative		2020	
Pesticide Type	**Count**	**Percent**	**Count**	**Percent**
Disinfectant	1151	37.7%	15	13.2%
Insecticide	982	32.1%	26	22.8%
Insect Repellent	218	7.1%	5	4.4%
Herbicide	207	6.8%	5	4.4%
Rodenticide	58	1.9%	1	0.9%
Fungicide	26	0.9%	1	0.9%
Multiple	201	6.5%	14	12.1%
Other	80	2.6%	2	1.8%
Unknown	133	4.4%	45	39.5%
Total	**3056**	**100.0%**	**114**	**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, spills and splashes were the most common contributing factor for non-occupational pesticide cases, followed by mixing incompatible products (Table 11).

Table 11: Contributing Factors in Confirmed Non-occupational Cases, 2006-2020 & 2020

	Cumulative		2020	
Contributing Factor	**Count**	**Percent**	**Count**	**Percent**
Mixing incompatible products	472	14.4%	19	15.6%
Label violations not otherwise specified	432	13.1%	25	20.5%
Spill / Splash of liquid or dust (not equipment failure)	314	9.6%	3	2.5%
Excessive application	277	8.4%	18	14.8%
No label violation identified but person still exposed / ill	238	7.2%	9	7.4%
Within reach of child or other improper storage	230	7.0%	8	6.6%
People were in the treated area during application	145	4.4%	13	10.7%
Drift contributory factors	109	3.3%	0	0.0%
Decontamination not adequate or timely	104	3.2%	2	1.6%
Structure inadequately ventilated before re-entry	96	2.9%	11	9.0%
Early re-entry	89	2.7%	6	4.9%
Intentional harm	75	2.3%	1	0.8%
Notification / Posting lacking or ineffective	60	1.8%	2	1.6%
Application equipment failure	50	1.5%	0	0.0%
Required eye protection not worn or inadequate	18	0.5%	0	0.0%
Required gloves not worn or inadequate	17	0.5%	1	0.8%
Applicator not properly trained or supervised	10	0.3%	0	0.0%
Other required PPE not worn or inadequate	8	0.2%	0	0.0%
Required respirator not worn or inadequate	2	0.1%	0	0.0%
Illegal pesticide used / illegal dumping	2	0.1%	1	0.8%
Other	90	2.7%	3	2.5%
Unknown	448	13.6%	0	0.0%
Total	**3286**	**100.0%**	**122**	**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 2020:

- The pesticide surveillance program coordinator provided case summaries 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 2020.

- No MDARD or MIOSHA Investigations were conducted on cases reported in 2020.

Discussion

Surveillance Data

There were 46 confirmed occupational cases reported in 2020. 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 104 confirmed non-occupational cases in 2020. This is consistent with the range from previous years of surveillance (102-447) but lower than the average number of cases for those years (193). 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 2020, 20% of occupational cases and 13% 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 2020, label violations not otherwise specified, for example spraying into the wind, were the most common factor for confirmed occupational cases (26%), followed by mixing incompatible products (21%). The most common factors contributing to non-occupational exposures were similar, with label violations not otherwise specified (20.5%) as the leading cause, followed by mixing incompatible products (16%) and excessive application (15%). Better education and labeling might help to reduce the number of exposures.

Many confirmed cases in 2020 were “bystanders”, i.e., engaged in work or living activities not related to the pesticide application (37% of occupational cases and 17% 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 2020, 72% of confirmed occupational cases and 60% 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, 2020 Confirmed Occupational Cases

Below are descriptions of the confirmed occupational cases reported in 2020. 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

MI5571- A male in his 40's was working on a farm where he was spraying an insecticide. He was wearing a respirator. When he was done working, he began having symptoms of shortness of breath, throat irritation, and a rash. He went to the hospital for medical assistance where they diagnosed him with having acute chemical pneumonitis.

Pest Control

MI5514- A male in his 20's was working as a pest control operator. He was using a backpack sprayer and the backpack had a leak on his right side. He developed muscle spasms and skin irritation. He called poison control for medical advice.

MI5546- A male in his 20's was working as a pest control operator for a pest control service. He was spraying a different than normal pesticide for the past week and developed dermal irritation and redness. He sought medical treatment in the emergency department and there they called poison control for medical advice.

Miscellaneous/unknown

MI5459- A restaurant server in her 30s came into work the night after a fogger had been set off for cockroaches. The space was poorly ventilated, and she inhaled the fumes. She developed a cough and a skin rash and called poison control.

MI5461- A pregnant female in her 20s was exposed to RAID when her coworker used an entire can in the office. She inhaled these fumes and developed a headache and dizziness. She then called poison control.

MI5462- A male in his 50s was exposed to RAID when his coworker used an entire can in the office. He developed a headache, dizziness, and eye irritation and called poison control.

MI5515- A male in his 20's was working in a green house and was left in the room while it was being fumigated. He developed a cough, shortness of breath, dizziness, and lightheadedness and sought medical treatment in the emergency department. There he was diagnosed with having a chemical exposure poisoning.

MI5565- A male in his 20's was working for the maintenance department of a state park. He was using a bee, wasp, and hornet killer pesticide on a building and accidentally got it in his eye. His eye became red and irritated, so they called poison control for medical assistance.

Herbicides

Agriculture

MI5490- A male in his 20s lives and works on his family farm. He was handling a urea-substituted herbicide and developed ocular irritation and pain, lacrimation, and conjunctivitis. He went to the emergency department to receive medical care and there they called poison control.

Landscaping

MI5563- 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 accidentally 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.

Miscellaneous/unknown

MI5489- A male in his 20s had an ocular exposure to python dust while unloading shipping boxes at a farm supply store. A bottle of python dust was damaged when he opened the box, and the dust got in his eye. He developed ocular irritation and pain. He called poison control for medical advice.

MI5564- A male in his 20's was working for a City's public works department when he was using an herbicide. He accidentally sprayed the herbicide in his eye and developed blurred vision, redness, and a burning sensation. He went to the emergency department for medical treatment where they diagnosed him with having acute chemical conjunctivitis.

Disinfectants

Agriculture

MI5678- A male in his 40s was working on a fruit tree farm when he was exposed to fumes from a mixture of bleach and acid. A co-worker mixed these chemicals, and he was trying to dispose

of the mixture. He developed throat irritation, chest tightness, and a cough. He sought medical attention in the emergency department.

Cleaner/housekeeper/janitor/custodian
MI5463- A hospital cleaner in her teens was cleaning with bleach. She then developed a rash and had skin irritation. She sought medical treatment in the emergency department.

MI5465- A hotel housekeeping worker in her 30s mixed bleach and toilet bowl cleaner. She inhaled the toxic fumes that are produced when these chemicals mix and developed a cough, wheezing, shortness of breath, and eye irritation. She sought medical treatment in the emergency department where she was diagnosed with chemical induced pneumonitis.

MI5472- A female in her 50s that works as a housekeeper was cleaning the bathroom with bleach and another cleaner. When the two cleaning agents mixed together, she inhaled the toxic fumes. She developed a headache, a cough, shortness of breath, and wheezing. She sought medical treatment in the emergency department.

MI5473- A female in her 30s that works as a cleaner for a cleaning company was cleaning with bleach. She inhaled the fumes and developed shortness of breath and lower and upper respiratory irritation. She sought medical treatment in the emergency department and was diagnosed with having chemical pneumonitis.

MI5482- A female in her 50s was working as a janitor in a manufacturing plant. She was overusing bleach because of COVID-19. She developed a cough and chest tightness. She called poison control.

MI5488- A female in her 30s works for a cleaning company. She was cleaning banks more frequently and with stronger products because of COVID-19. She developed a cough, shortness of breath, headaches, dizziness, burns, throat irritation, and nausea. She called poison control for medical advice.

MI5566- A female in her 30's was working for a cleaning company and mixed bleach and an ammonia-based disinfectant on accident, producing chloramine gas. She started experiencing a cough, shortness of breath, and throat irritation. She called poison control for medical advice.

MI5567 & MI5568- A male in his 30's and a male in his 40's entered an apartment complex to clean. They were unaware that a bed bug and flea fogger had recently been set off inside. They both started experiencing shortness of breath and fatigue and went to the emergency room for medical evaluation.

MI5570- A male in his 50's was working as a janitor when he accidentally mixed bleach and an ammonia-based disinfectant, producing chloramine gas. He was wearing a cloth mask. He experienced a headache, lightheadedness, and dizziness, and called poison control for medical advice.

MI5677- A female in her 30s was working as a supervisory janitor cleaning office spaces when she sprayed an antimicrobial on various surfaces. She was not allowed to wear PPE to decrease office workers' concerns with COVID-19. She developed a headache, a cough, wheezing, chest tightness, and a blister-like rash on her hands. She sought advice from poison control and was prescribed an inhaler by her primary care doctor.

MI5679- A female in her 60s was working as a custodian at a hospital when she was exposed to fumes from bleach she was cleaning with. She developed a cough, shortness of breath, itching in her throat, and sinus congestion. She sought medical attention in the emergency department.

MI5680- A female in her 60s was working in housekeeping at a hospital when she was exposed to fumes from cleaning chemicals as well as floor stripping and waxing fumes. She developed wheezing, a cough, and shortness of breath. She sought medical advice from her primary care physician.

Food service/production
MI5327- A teenaged dishwasher splashed dishwashing liquid in his face. His skin became red and irritated, and he called poison control.

MI5468- A male in his 50s was cleaning machinery with muriatic acid and bleach at a dairy factory. He developed shortness of breath and respiratory irritation. He called poison control for medical advice.

MI5510- A male in his 40’s was working as a cook in a restaurant when his coworker mixed bleach and citric acid. He inhaled the fumes from this incompatible chemical mixture and developed throat irritation. He went to the emergency department for medical treatment. They called poison control at the emergency department for medical advice.

Healthcare
MI5319- An EMT was cleaning at work and got DMC damp mop in eye on accident. His eye became red and irritated, and he went to the emergency department.

MI5682- A female in her 50s was working as a medical assistant in a pediatric clinic when she was exposed to fumes from a specific disinfectant. She developed a cough, shortness of breath, fatigue, and chest pain. She develops these symptoms even when she is not the applicator of the disinfectant. She sought medical attention in the emergency department.

Miscellaneous/unknown
MI5460- A worker in her 50s was cleaning with Clorox at work when it got in her eye. She developed eye pain and sought medical treatment where she was diagnosed with having an abrasion.

MI5466- A female in her 40s was cleaning the bathroom at work and mixed bleach with another cleaning product. She inhaled the fumes and developed a cough, shortness of breath, and a sore throat. She called poison control and then sought medical treatment in the emergency department.

MI5467- A female in her 60s had an allergic reaction at work from the cleaning chemicals used in the office. There were many different chemicals used during this time because of COVID-19. She developed shortness of breath, skin irritation, and nausea. She sought medical treatment in the emergency department.

MI5479- A female in her 20s was cleaning with bleach at work. She inhaled the fumes and developed respiratory irritation. She sought medical treatment in the emergency department and was diagnosed with an inhalation injury.

MI5481- A male in his 20s was working as a greeter in a grocery store. He was overusing a disinfectant on the shopping carts because of COVID-19 in a smaller enclosed space. He developed a cough and respiratory irritation. He called poison control.

MI5486- A female in her teens was cleaning with a high concentration of bleach at work in a poorly ventilated area. She developed chest pain, shortness of breath, and throat irritation. Her husband called poison control and they then went to the emergency department where she was given an inhaler.

MI5487- A male in his 40s developed respiratory irritation after a cleaning company came into his workplace due to COVID-19. They used bleach and other disinfectants and he inhaled the fumes. He went to urgent care to receive medical treatment.

MI5493- A male in his 50s works for a heating and cooling construction company. Him and two others were doing carpentry work on top of an industrial building when they started to smell chlorine. They noticed a cloud of gas near them. They later found out another company was working inside the building cleaning up a chemical spill, where they accidentally mixed chemicals creating chlorine gas. He developed a cough, shortness of breath, chest pain, and a headache. They all went to receive medical treatment from the emergency department where they were diagnosed with having a chemical inhalation injury. They called poison control at the emergency department. (1 of 3)

MI5494- A male in his 30s works for a heating and cooling construction company. Him and two others were doing carpentry work on top of an industrial building when they started to smell chlorine. They noticed a cloud of gas near them. They later found out another company was working inside the building cleaning up a chemical spill, where they accidentally mixed chemicals creating chlorine gas. He developed upper and lower respiratory irritation, watering eyes, dizziness and lightheadedness. They all went to receive medical treatment from the emergency department where they were diagnosed with having a chemical inhalation injury. They called poison control at the emergency department. (2 of 3)

MI5495- A male in his 50s works for a heating and cooling construction company. Him and two others were doing carpentry work on top of an industrial building when they started to smell chlorine. They noticed a cloud of gas near them. They later found out another company was working inside the building cleaning up a chemical spill, where they accidentally mixed chemicals creating chlorine gas. He developed a cough, chest pain, and shortness of breath. They all went to receive medical treatment from the emergency department where they were diagnosed with having a chemical inhalation injury. They called poison control at the emergency department. (3 of 3)

MI5569- A male in his 30's was using a disinfectant cleaner while working at a lumber yard. The cleaner accidentally splashed in his eye and he started to experience pain and irritation. He went to the emergency room for medical evaluation where they called poison control.

MI5681- A female in her 40s was exposed to fumes of aerosol disinfectants while working in receiving of a warehouse. She developed shortness of breath and sought medical attention in the emergency department.

MI5683- A female in her 50s worked as a front desk receptionist at a doctor's office where she uses bleach to clean every day. She developed a cough and wheezing and began using her inhaler more often. She sought medical advice from poison control and sought medical care from her primary care doctor.

Other/Mixture

MI5485- A male in his 50s was using the fungicide switch at work when he spilled it on himself. He then went to eat lunch and did not wash his hands. He thinks he ingested the pesticide and developed face swelling and throat irritation. He went to the emergency department and was diagnosed with acute pharyngitis.

MI5498- A male in his 20's was working a job with chemicals 8 hours a day, 5 days a week for a few months without any PPE. He developed abdominal pain, nausea, diarrhea, a rash, and weight loss. He went to the emergency department for medical treatment. They called poison control at the emergency department.

MI5547- A male in his 50's was carrying two buckets of the fungicide Acticide at work and spilled some on his legs. He developed swelling, redness, blisters, and pain and sought medical treatment in the emergency room where they called poison control. He was diagnosed with a chemical burn.