Non-Occupational Disinfectant Illness and Injury Surveillance in Michigan, 2006-2013

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Division of Environmental Health

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Contents

Introduction

Disinfectants are widely used as a means of controlling and preventing the spread of infectious diseases, but they contain chemicals that can have adverse health effects on humans. Exposure to chemicals in disinfectants can occur during mixing, application, and after spills. Disinfectants are regulated as pesticides by the US Environmental Protection Agency (EPA). This report summarizes information on acute non-occupational disinfectant-related illness and injury cases reported to Michigan's pesticide illness-injury surveillance system for the eight-year period, 2006-2013. The goals of this analysis are to identify groups at risk for disinfectant-related illnesses and injuries, detect trends, identify high-risk active ingredients, and provide information for planning and evaluating intervention programs.

Background

Disinfectants are chemical or physical agents use to inactivate or kill bacteria, viruses, fungi, and protozoa on surfaces.[1] They are used in a variety of settings, including janitorial services; institutional, commercial, and consumer settings; food preparation; water purification; and treatment of waste water.[1] Their effectiveness depends on the concentration of their active ingredients, duration of exposure, PH levels, and other factors.[2] More than 5,000 disinfectants are registered with the EPA. Different types of disinfectant contain one or more of about 275 active ingredients. They are marketed in different formulations (e.g., Sprays, liquids, concentrated powders, and gases) with an annual market value of $1 billion.[2]

Disinfectants are classified into two categories, based on the type of microbial pest against which the product works:

I. Non-public health products (e.g., control algae, odor-causing bacteria, and microorganisms infectious to animals)
II. Public health products (e.g., sterilizers, disinfectants, sanitizers, and antiseptics) to control microorganisms infectious to human.

Two major uses of public health disinfectants products;

- ***Use on instruments, floors, walls, bed linens, and toilet seats in hospitals.***
- ***General-use in households, swimming pools, and water purifiers.***

Different types of disinfectants contain different active ingredients. One common ingredient is sodium hypochlorite (NaOCl), the active ingredient in household bleach. NaOCl is associated with adverse health risks due to its strong oxidizing properties. These risks range from mild respiratory symptoms to

kidney injury, depending on route of exposure and amount.[3,4] Some disinfectants are added to swimming pool water to inactivate pathogens and to improve the quality of the water. A common active-ingredient in pool products is calcium hypochlorite $Ca(ClO)_2$. Inhalation of $Ca(ClO)_2$ can be responsible for respiratory symptoms, ranging from upper respiratory tract irritation to more severe symptoms.[5]

Disinfectants are regulated by the EPA to protect the human health and environment.[2] In spite of their health hazards, disinfectants are widely used in homes and commercial and institutional settings.

This report provides public health surveillance data on the impact of disinfectants on human health in Michigan.

Methods

Injuries and illnesses caused by exposure to disinfectants, which are one class of pesticides, are included in a surveillance system that tracks illnesses and injuries from exposure to all classes of pesticides. In 2001, the Michigan Department of Community Health (MDCH)[†] initiated an occupational pesticide illness and injury surveillance program, with funding from the National Institute for Occupational Health (NIOSH) under its Sentinel Event Notification System for Occupational Risk (SENSOR) Pesticides Surveillance program.[6,7] In 2006 MDCH added collection of data on non-occupational pesticide exposure illnesses.[8]

Disinfectants are one class of EPA-regulated pesticides. Other classes include insecticides, fungicides, rodenticides, herbicides, and fumigants.

The goals of the pesticide surveillance system are to characterize the pesticide-poisoning problem in Michigan and prevent adverse health effects from pesticide exposures. The surveillance data are used to detect trends and identify the following:

- Groups at risk for pesticide-related illnesses,
- Clusters/outbreaks of pesticide-related illnesses,
- High-risk active ingredients,
- Illnesses that occur even when the pesticide is used correctly,
- Cases that need to be referred to regulatory agencies for interventions,
- Targets for educational and other public health interventions.

Pesticide poisoning, including disinfectant-related, 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 information about individuals (including their names) with known or suspected pesticide poisoning to the state. Beginning in 2006, the Poison Control Center (PCC) began reporting non-occupational cases where the reason for exposure was coded "Unintentional – Environmental." To fully capture environmental exposures, in 2012 the reasons for exposure were expanded to "Unintentional – General," "Unintentional – Misuse," or "Unintentional – Unknown."

[†] Data collection and preparation of this report were conducted prior to the merger of the Michigan Department of Community Health and Human Services (MDHHS)into the new Michigan Department of Health and Human Services. Thus the MDCH agency name is used throughout this report rather than MDHHS.

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 regulates pesticide usage in the state and handling complaints about pesticide misuse and health effects and conducting investigations to address potential violations of pesticide laws. Other sources of pesticide-related illnesses data include Michigan's Hazardous Substances Emergency Event Surveillance (HSEES) program; the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) adverse effects reports; coworkers; and worker advocates.

The MDCH pesticide poisoning surveillance system is a case-based system, meaning an individual must meet the case definition established by NIOSH and the participating states[9] to be included as a confirmed case. Data are collected from the case reports according to standardized variable definitions in a database developed for states that are conducting pesticide surveillance. Information in the database about each case includes demographics, sources of the case report activity and place at time of exposure, name and class of pesticide, active ingredients, routes of exposure, symptoms, and treatment.

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. The possible classifications are: definite, probable, possible, suspicious, unlikely, insufficient information, exposed but asymptomatic, or unrelated.[9] Cases classified as definite, probable, possible or suspicious (DPPS) are considered confirmed cases and are included in all data analyses.

Confirmed cases are evaluated regarding the severity of the health effect: low, moderate, high and death. The severity index is based on the signs and symptoms experienced, whether medical care was sought, whether a hospital stay was involved, and whether time was lost from work or daily activities.[10]

For this analysis, confirmed non-occupational disinfectant cases 2006-2013 were identified in the surveillance database by product and activity codes, and exported into Microsoft Excel file for analysis. Descriptive analysis was performed for the years 2006-2013 and 2013. Data for 2013 were summarized separately to see if the most recent year of data were different than trends overall because of changes in case reporting from the PCC in 2012.

Results

Of the 2,558 confirmed pesticides cases in the surveillance system 2006-2013, 641 (25%) were confirmed non-occupational disinfectant cases. Figure 1 shows the number of non-occupational disinfectant cases by year.

Figure 1

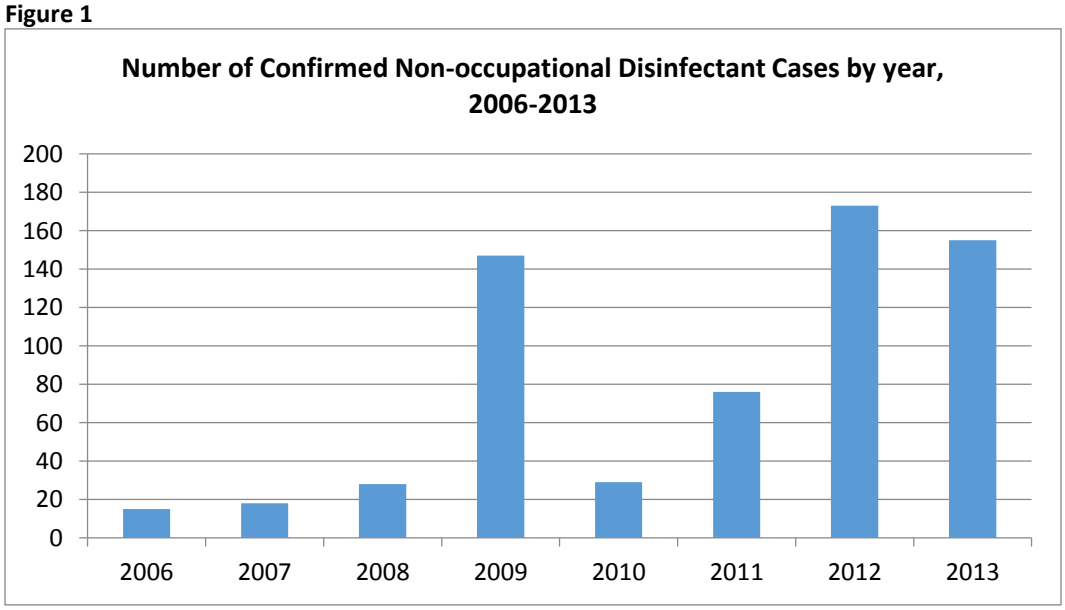


Table 1: Percentage of Non-Occupational Disinfectant Cases by Month of Exposure, Michigan, 2006-2013 (*n*=641) and 2013 Only (*n*=156)

Month	2006 -2013		2013	
	#	%	#	%
January	45	7	7	5
February	61	10	10	7
March	86	13	17	11
April	57	9	11	7
May	47	7	14	9
June	68	11	25	16
July	63	10	21	14
August	67	11	15	10
September	48	8	10	7
October	43	7	5	3
November	30	5	11	7
December	26	4	10	7
Total	**641**	**100%**	**156**	**100%**

Figure 2

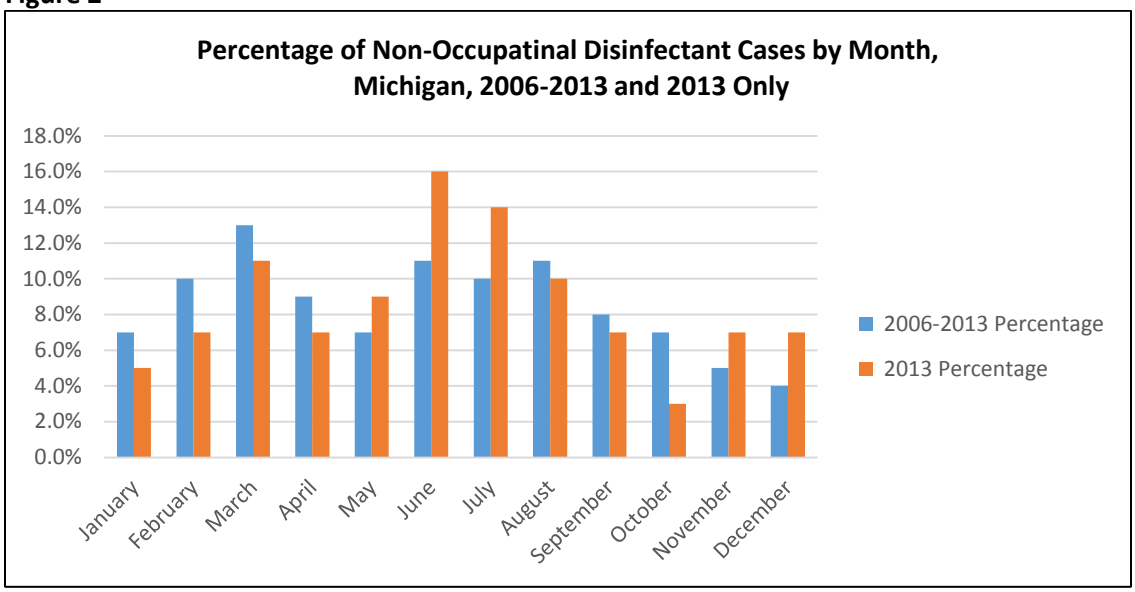


Figure 2 shows an increase in the number of cases (for all years combined (2006-2013) and 2013) during the summer months (June-August) and in March. For all years combinedalmost one-third (31%) of the confirmed cases fell during the summer, and more than one-third (38%) of the 2013 cases took place during the summer.

Demographics

Table 2 shows confirmed non-occupational disinfectant cases by age groups and sex for both time periods. Age was known for 617(96%) of the cases, and sex was known in all cases. Although disinfectant exposures occurred to people of all ages and sex, the highest risk group was females over age 40; this accounted for 182 (48%) of all females and 29% of all cases.

Table 2: Number of Non-Occupational Disinfectant Cases by Age Group and sex, Michigan, 2006-2013 (*n*=617) and 2013 Only (*n*=155)

Age group	2006 -2013				2013			
	Female		Male		Female		Male	
	#	%	#	%	#	%	#	%
0-10	21	6	33	14	2	0	10	15
11-20	31	8	29	12	8	9	6	9
21-30	73	19	40	17	15	17	7	11
31-40	69	18	34	14	15	17	11	17
>40	182	48	105	44	49	55	31	47
Total	376	100	241	100	89	100	66	100

Race and ethnicity information is not included because that information was available for less than 5% of the cases.

Map 1 shows ranges of numbers of confirmed cases by county. The largest numbers of cases were in the south-eastern counties of Michigan, mainly in Wayne, Oakland, and Macomb Counties.

Map 1: Number of Confirmed Non-Occupational Disinfectant Cases by County, Michigan, 2006-2013 (*n*=641)

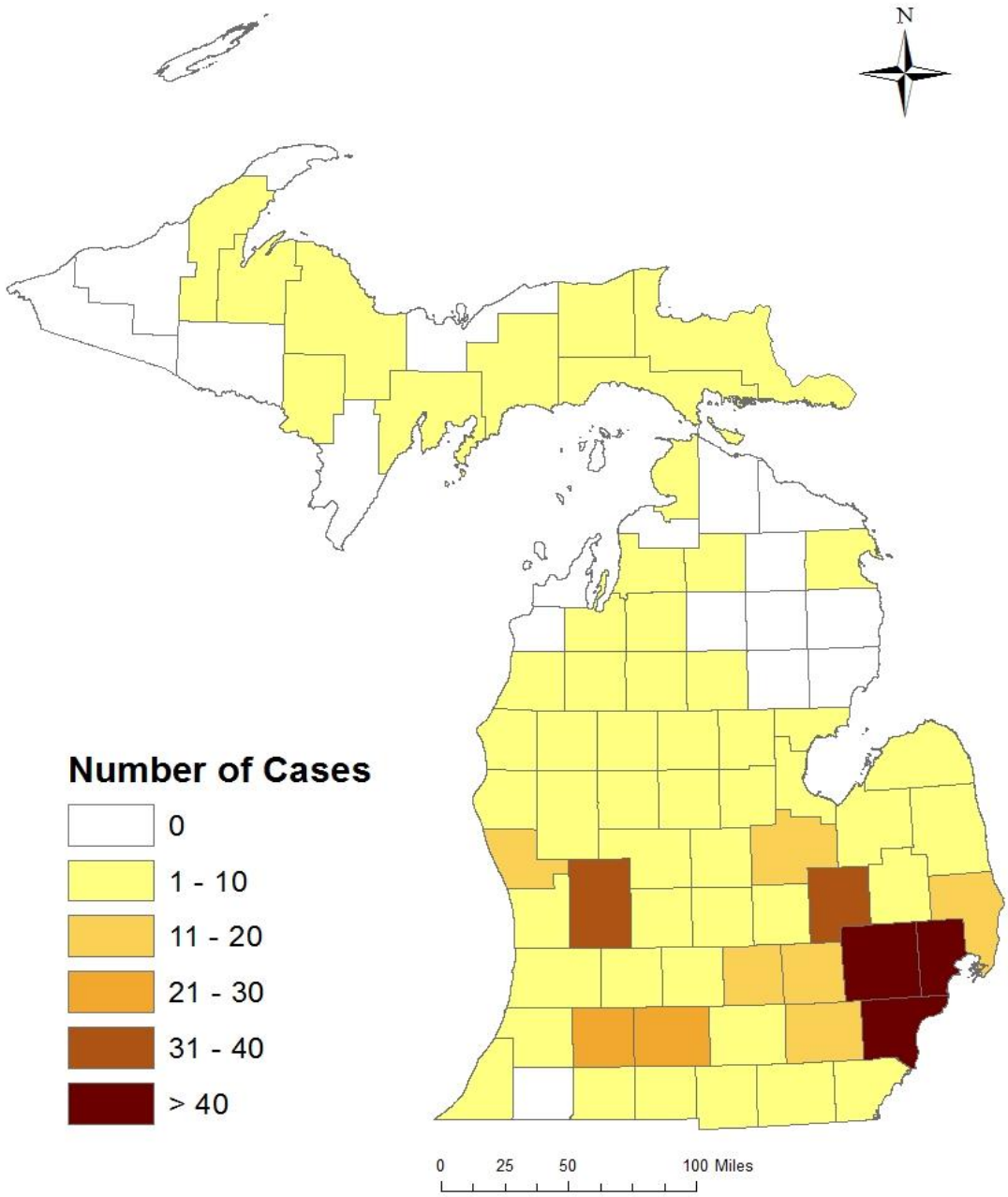


Table 3 lists the numbers of cases by report source. Some cases were reported by more than one source; however, Table 3 lists the first-reported source only. The Poison Control Center (PCC) reported half of the cases (50%) for all years combined. In 2013, 88 (56%) of the 155 non-occupational disinfectant cases were reported by hospitals and 60 (39%) were reported by the PCC.

Table 3: Number of Non-Occupational Disinfectant Cases by First Report Source, Michigan, 2006-2013 (*n*=641) and 2013 Only (*n*=156)

	2006-2013		2013	
Report Source	**#**	**%**	**#**	**%**
Department of Agriculture and Rural Development	6	1	0	0
Obituary/new report	7	1	2	1
Hospitals	181	28	88	56
Physician report	6	1	6	4
Poison control center	320	50	60	39
Report/ referral from governmental agency	8	1	0	0
State health department-HSEES*	102	16	0	0
State health department-NPDS&	11	2	0	0
Total	**641**	**100**	**156**	**100**

Abbreviation:
* Hazardous Substances Emergency Events Surveillance.
& National Poison Data System.

The activity at time of exposure was known for 610 (95%) and 151 (97%) of the confirmed cases in 2006-2013 and 2013, respectively. Of cases for which where activity was known, more than one-third of the cases (42% in 2006-2013 and 37% in 2013) involved exposure during disinfectant application.

Table 4: Number of Non-Occupational Disinfectant cases by Activity, Michigan, 2006-2013 (*n*=610) and 2013 Only (*n*=151)

	2006 -2013		2013	
Activity	**#**	**%**	**#**	**%**
Applying pesticide	254	42	56	37
Mixing or loading	25	4	13	9
Transport or disposal	3	1	1	1
Any combination of above	168	28	44	29
Indoor-routine living	122	20	25	17
Outdoor-routine living	21	3	6	4
Application to self	3	1	2	1
Not applicable	14	2	4	3
Total	**610**	**100**	**151**	**100**

Exposure

"Exposure type" describes how cases come in contact with a disinfectant. There are several different types of exposure, and individuals can have more than one exposure type:

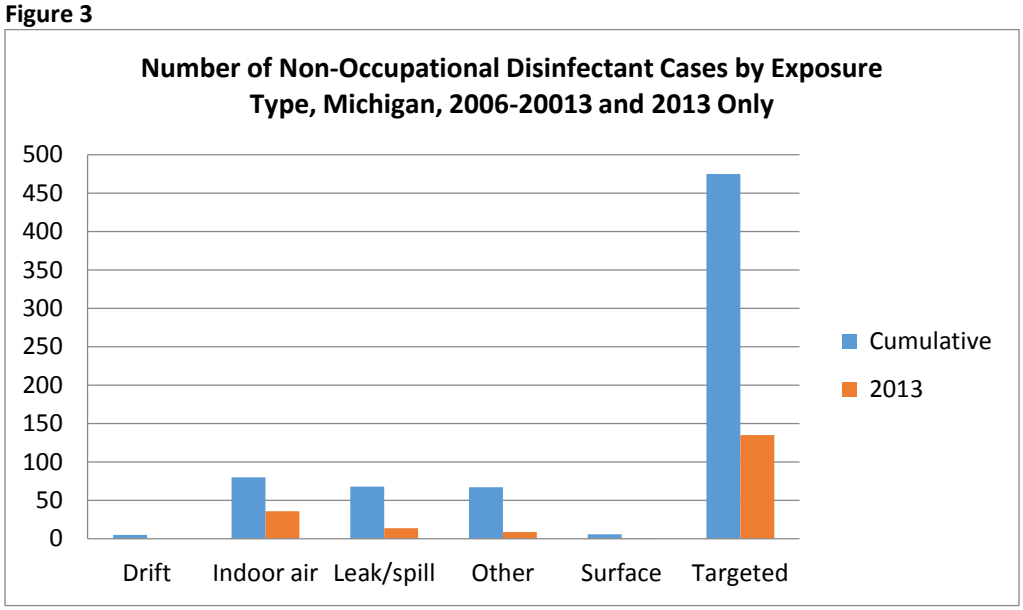
i. "Drift" exposures occur when an individual is exposed by the movement of disinfectant away from the application site.
ii. "Indoor air" exposures occur via contaminated indoor air.
iii. "Leak/spill" exposures occur when an individual is exposed to a leak or spill of disinfectant material from any cause.
iv. **"**Other"- indicates when any other type of exposure occurs (e.g., accidental ingestion of a disinfectant stored in a drinking bottle).
v. "Surface" exposures occur when an individual is exposed via contact with disinfectant residues on a treated surface.
vi. "Targeted" exposures occur when a disinfectant is released at the target site.

Targeted exposure accounted for 475 (68%) and 135 (69 %) of the type of exposure in 2006-2013 and 2013, respectively.

Table 5: Number of Non-Occupational Disinfectant Cases by Exposure Type, Michigan, 2006-2013 (*n*=701) and 2013 Only *(n*=195)

	2006 -2013		2013	
Exposure type	**#**	**%**	**#**	**%**
Drift	5	1	0	0
Indoor air	80	11	36	19
Leak/spill	68	10	14	7
Other	67	10	9	5
Surface	6	1	1	1
Targeted	475	68	135	69
Total	**701**	**100**	**195**	**100**

Figure 3



Inhalation and eye contact were the primary routes of exposure. There were more numbers on route of exposure (688 and 168 in 2006-2013 and 2013, respectively) than case numbers because some cases were exposed through more than one route. In 2013, the most frequently reported route of exposure was inhalation, 128 (76%) of 168 reported routes (Table 6).

Inhalation exposure scenarios include inhalation of contaminated air,

- While applying disinfectant
- While being in an area with others applying disinfectant
- During accidental spills
- During the mixing of incompatible chemicals or opening disinfectant containers

Table 6: Number of Confirmed Non-Occupational Disinfectant Cases by Route of Exposure, Michigan, 2006-2013 (*n*=687) and 2013 Only (*n*=168)

	2006 -2013		2013	
Route of Exposure	**#**	**%**	**#**	**%**
Dermal	46	7	4	2
Ingestion	49	7	7	4
Inhalation	489	71	128	76
Ocular	103	15	29	17
Total	**687**	**100**	**168**	**100**

Figure 4

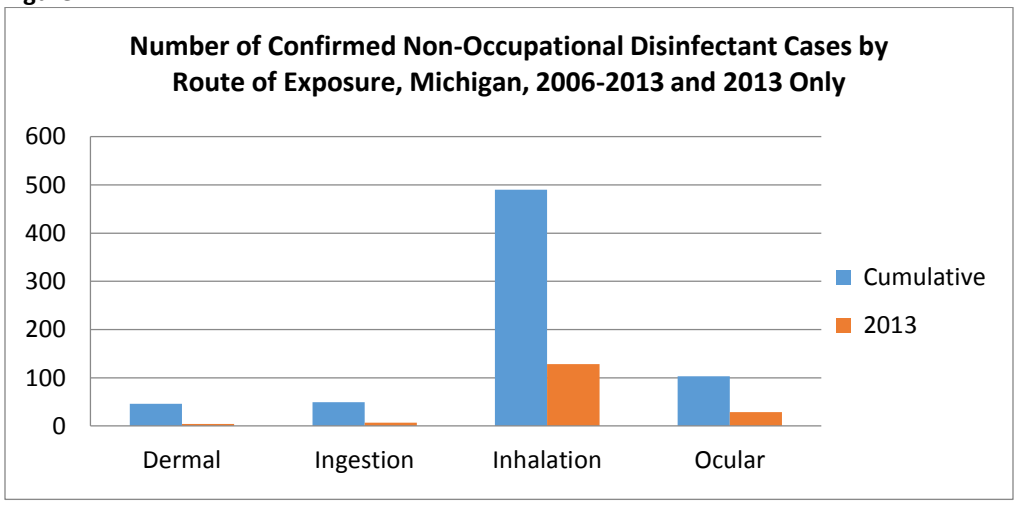
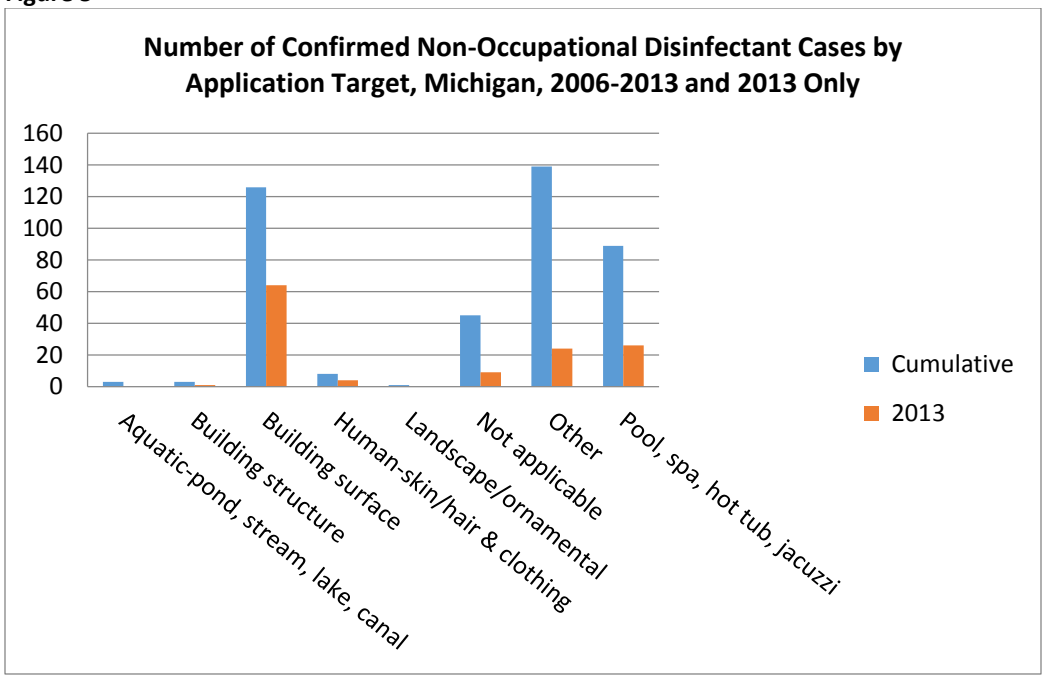


Table 7 shows the distribution of targets for the disinfectant applications, where known. There were 413 (65%) and 128 (82%) known application targets in 2006-2013 and 2013 only, respectively. The most common application target for the period 2006-2013 was coded "Other," 139 (34%) of known targets, which included disinfection of toilets and other special target sites. In 2013, the most common application target was "Building Surface," which accounted for half of the known application targets. Building surface included spraying to carpets, and interior areas surface.

Table 7: Number of Confirmed Non-Occupational Disinfectant Cases by Application Target, Michigan, 2006-2013 (*n*=413) and 2013 Only (*n*=128)

	2006-2013		2013	
Application target	**#**	**%**	**#**	**%**
Aquatic-pond, stream, lake, canal	3	1	0	0
Building structure	3	1	1	1
Building surface	126	30	64	41
Human-skin/hair & clothing	7	2	4	3
Landscape/ornamental	1	1	0	0
Not applicable	45	11	9	6
Other	139	34	24	15
Pool, spa, hot tub, jacuzzi	89	22	26	17
Total	413	100	128	100

Figure 5

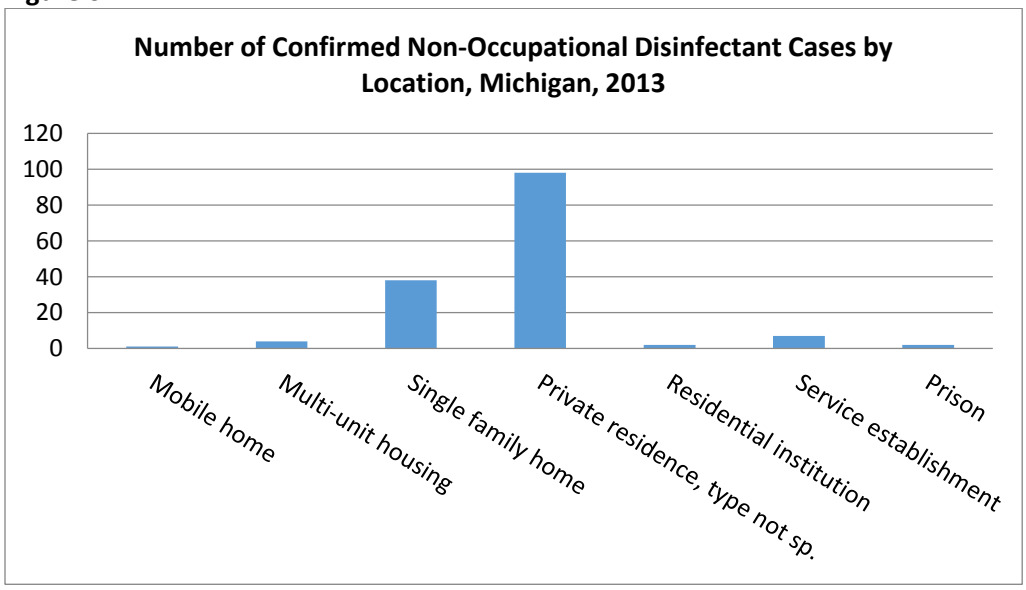


Location of exposure was identified in almost all (613 of 641) cases and almost all (93%) were in the home.

Table 8: Location of Exposure for Confirmed Non-Occupational Disinfectant Cases, Michigan, 2006-2013 (*n*=613) and 2013 Only (*n*=152)

	2006-2013		2013	
Location	**#**	**%**	**#**	**%**
Mobile home	5	1	1	1
Multi-unit housing	19	3	4	3
Single family home	269	44	38	2
Private residence, type not sp.	278	45	98	65
Residential institution	3	1	2	1
Service establishment	16	3	7	5
Retail establishment	2	0	0	0
Park	2	0	0	0
Farm	1	0	0	0
School	12	2	0	0
Prison	4	1	2	1
Other	2	0	0	0
Total	**613**	**100**	**152**	**100**

Figure 6

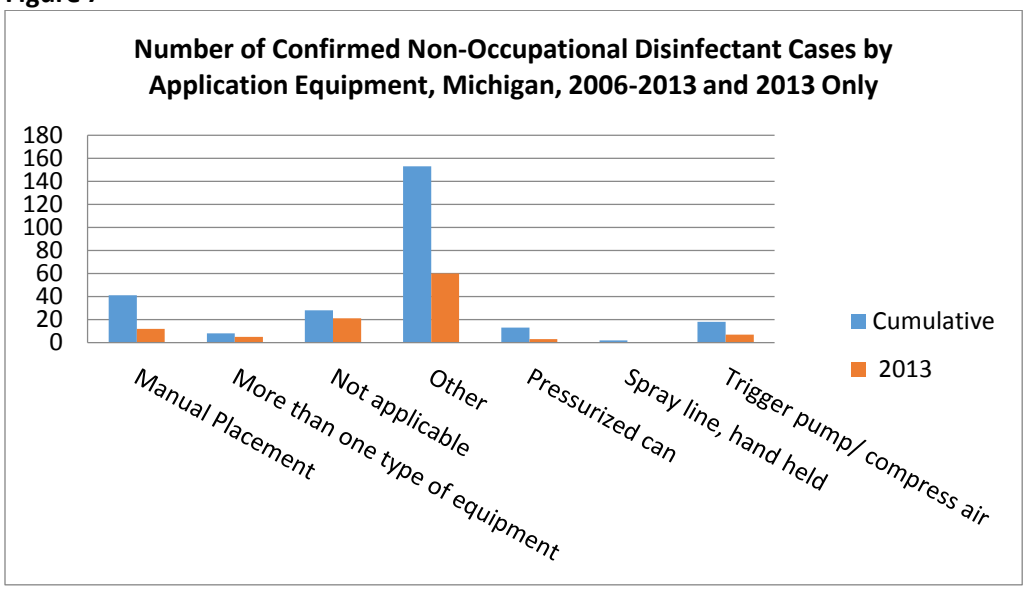


The application equipment used for applying disinfectant was known for 41% and 69% of the non-occupational disinfectant cases in 2006-2013 and 2013 only, respectively. In 2006-2013 and 2013 only, the most common equipment type was "other" (58% and 39% of known types, respectively), which included mop buckets and pouring directly from a bottle.

Table 9: Equipment Used in Confirmed Non-Occupational Disinfectant Cases, Michigan, 2006-2013 (*n*=662) and 2013 Only (*n*=149)

	2006-2013		2013	
Application Equipment	**#**	**%**	**#**	**%**
Manual Placement	41	16	12	8
More than one type of equipment	8	3	5	3
Not applicable	28	11	21	14
Other	152	58	60	39
Pressurized can	13	5	3	2
Spray line, hand held	2	1	0	0
Trigger pump/ compress air	18	7	7	5
Total	**262**	**100**	**149**	**100**

Figure 7



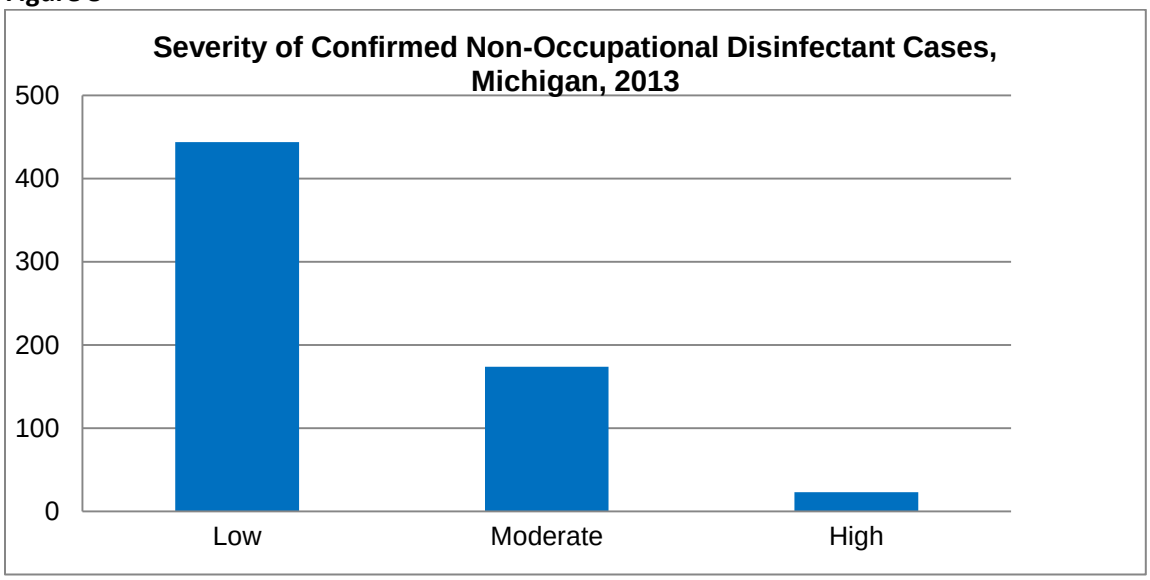
Health Effects

Severity of health effects ("severity index"[‡]) takes into account the following: signs and symptoms, medical care, hospitalization, and lost time from work or usual activities. The majority of the cases were considered low in severity.

Table 10: Severity of Confirmed Non-Occupational Disinfectant Cases, Michigan, 2006-2013 (*n*=641) and 2013 Only (*n*=156)

	2006-2013		2013	
Severity	**#**	**%**	**#**	**%**
Low	444	69	76	49
Moderate	174	27	72	46
High	23	4	8	5
Total	**641**	**100**	**156**	**100**

Figure 8



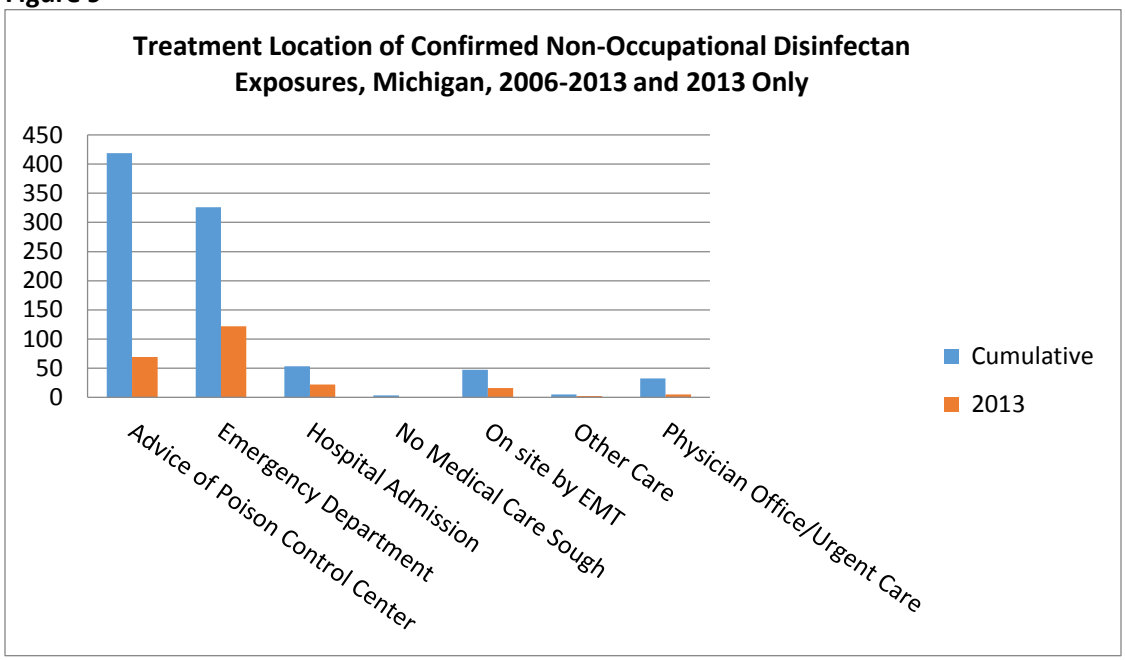
[‡] See p. 6 and reference #10 for definition of "severity index"

Table 11 shows the treatment locations for patients with confirmed disinfectant exposures. Some individuals received medical care from more than one place, typically first receiving advice from the poison control center and then going to an emergency department. Only 53 (8%) of the 641 cases were admitted to hospitals. Because some persons received care from more than one source, the total number of treatment locations is greater than total number of cases.

Table 11: Treatment Location of Persons with Confirmed Non-Occupational Disinfectant Exposures, Michigan, 2006-2013 (*n*=884) and 2013 Only (*n*=236)

	2006-2013		2013	
Care Source	**#**	**%**	**#**	**%**
Advice of Poison Control Center	419	47	69	29
Emergency department	326	37	122	52
Hospital admission	53	6	22	9
No medical care sought	2	0	0	0
On site by EMT	47	5	16	7
Other care	5	1	2	1
Physician office/urgent Care	32	4	5	2
Total	**884**	**100**	**236**	**100**

Figure 9



Examples of Non-occupational Disinfectant-Related Illness Cases

- MI03588[§]- Female was up at 3 am with her infant when she decided to finish a cleaning project she had started earlier. She mixed toilet bowl cleaner and chlorine bleach and inhaled the fumes. Her symptoms were instant and severe. She experienced vomiting and wheezing. She went to the emergency department (ED) for treatment.
- MI02969- Female mixed bleach with toilet bowl cleaner and inhaled resulting fumes. She became dyspneic with upper and lower respiratory irritation. She received treatment at a local ED
- MI02766- Female grabbed and swallowed approximately 4 oz. of what she thought was apple juice, but was instead a mixture of cleaning products. She went to an ED complaining of nausea, coughing, and a choking sensation in her throat.
- MI03115- Female was treated in an ED because she was complaining of shortness of breath, wheezing, and coughing. She had inhaled chlorine while opening a container of pool chlorine.
- MI02183- Male was hospitalized after developing erythema, bleeding, blurred vision, red eye/conjunctivitis, bronchospasm, cough/choke, and dyspnea. He had been cleaning his basement with various chemicals prior to the onset of his symptoms.
- MI02582- Male poured pool chlorine granules into a bucket then added water, and it exploded. He was admitted to the hospital due to eye and face irritation, respiratory irritation, dyspnea, and dermal burns. He was found to have tachycardia, tachypnea, bilateral infiltrates, and pulmonary edema.
- MI03425- Male sought medical treatment at a physician office because of cough, tachypnea, shortness of breath, tearing, and pain in eyes after mixing bleach and ammonia. He was diagnosed with chemical pneumonitis.
- MI03506- Male was putting chlorine into a pool and then had respiratory symptoms. He went to an ED complaining of chest tightness, shortness of breath, wheezing, and coughing. He was diagnosed with acute chemical bronchitis.

[§] Assigned surveillance system case number

Discussion

For the eight-year period 2006-2013, 641 individuals reported to the surveillance system with acute disinfectant-related illness met the surveillance case definition of a confirmed case. Compliance with public health reporting requirements for pesticide illness likely varied by reporting source. Reporting by the Michigan Poison Control Center (PCC) is believed to be complete because case reports are identified by active case finding using standard codes in the PCC electronic case database. Compliance with reporting requirements by hospitals and EDs was also likely complete because cases are reported on the basis of discharge diagnosis codes for pesticide poisoning, which are in all electronic patient records.

However, compliance with reporting requirements for disinfectant-related illness and pesticide illness by individual health care providers has historically been very poor. Acute pesticide poisoning is a complex condition to recognize and diagnose because the diverse signs and symptoms experienced can resemble asthma attacks and other conditions with other etiologies. Health-care providers generally have limited education about disinfectant toxicity.[6, 8] Training and education of health-care providers on recognition of disinfectant illness and public health reporting requirements may help improve diagnosis and reporting.

Another limitation to be noted is missing data. For example, the surveillance system did not have information about race and ethnicity for 95% of the cases. Without resources to conduct additional follow-up with reported individuals, the surveillance system will continue to be limited to the information provided in the initial case reports.

Notable findings in this report include the following:

- The numbers of confirmed cases varied by year, with a spike in 2009, and increases from 2011 through 2013. Most of these variations by year were likely due to changes in reporting from the PCC based on changes in the algorithms used for searching the PCC's electronic case file, and not due to an increased incidence of illnesses in these years.
- Almost one-third of the exposures (31%) occurred during the summer months, June-August, which might have been due to increases in outdoor activities (e.g., swimming) during summer and more exposure to pool chemicals. The increase in cases during March might be due to increased indoor application and mixing of disinfectants during periods when windows are still closed for the winter, but where people are starting to do "spring cleaning."

- Although disinfectant-related illness occurred among people of all ages and both sexes, the majority were among females over age 40.
- Most of the cases (243/38%), were clustered in the southeast region of the state, mainly in Wayne, Oakland, and Macomb Counties. These three counties have the highest population densities in the state and accounted for 42% of the state's population.

One way to minimize the health effects of disinfectants is to use them only in situations where they have been shown to be effective in reducing infectious diseases. Also, cleaning products with lower toxicities are available, [11,12] although additional research is needed to understand their effectiveness and appropriate uses in preventing infectious diseases, particularly in healthcare settings. Targeting users of disinfectants (e.g., custodians, families with asthmatic children) with educational interventions to raise awareness about less toxic cleaning products and the safest ways to use disinfectants is recommended.

References

1. Brevard TA, Calvert GM, Blondell JM, *et al*. *Acute occupational disinfectant-related illness among youth*, 1993-1998. Environ Health Perspect 2003; 111(13):1654-59.
2. EPA. *What are Antimicrobial Pesticides?* 2015. Available at www2.epa.gov/pesticide-registration/what-are-antimicrobial-pesticides#Intro
3. Brandon P, Biruh W, Huseyin K, *et al*. *Spectrum of sodium hypochlorite toxicity in man—also a concern for nephrologists*. NDT Plus (2011) 0: 1–5. Available at http://ckj.oxfordjournals.org/content/early/2011/04/07/ndtplus.sfr053.full.pdf+html
4. Mehler L, Schwartz A, Diebolt-Brown, *et al*. *Acute Antimicrobial Pesticide-Related Illnesses Among Workers in Health-Care Facilities-California, Louisiana, Michigan, and Texas, 2002-2007*. MMWR May 14, 2010/59(18); 551-56
5. Hlavsa M, Robinson TJ, Collier SA, *et al*. *Pool Chemical-Associated Health Events in Public and Residential Settings-United States, 1983-2007*. MMWR May 16, 2014/63(19); 427-30, and JAMA. 2009; 301(24):2543–45.
6. Calvert GM, Plate DK, Das R, *et al*. *Acute occupational pesticide-related illness in the US, 1998-1999: surveillance findings from the SENSOR-pesticides program*. American Journal of Industrial Medicine 2004; 45:14–23.
7. CDC. *Pesticide Illness and Injury Surveillance*. Atlanta, GA: US Department of Health and Human Services: 2013. Available at http://cdc.gov/niosh/topics/pesticides/
8. Michigan Department of Community Health, Division of Environmental Health. *Pesticide Illness and Injury Surveillance in Michigan*: 2012. Available at http://michigan.gov/documents/mdch/Pesticide_Annual_report_2012_final_454516_7.pdf
9. CDC. *Case Definition for Acute Pesticide-Related Illness and Injury Cases.* Atlanta, GA: US Department of Health and Human Services, CDC: 2005. Available at http://cdc.gov/niosh/topics/pesticides/pdfs/casedef2003_revAPR2005.pdf
10. CDC. *Severity Index for Use in State-based Surveillance of Acute Pesticide-Related Illness and Injury,* Atlanta, GA: US Department of Health and Human Services, CDC: 2001. Available at http:/cdc.gov/niosh/topics/pesticides/pdfs/pest-sevindexv6.pdf
11. EPA. 2010. *Greening Your Purchase of Cleaning Products: A Guide For Federal Purchasers*. Available at http://epa.gov/epp/pubs/cleaning.htm.
12. EPA. 2014. *Design for the Environment Antimicrobial Pesticide Pilot Project: Moving Toward the Green End of the Pesticide Spectrum*. Available at www.epa.gov/pesticides/regulating/labels/design-dfe-pilot.html.