April 14th, 2014

2012 Annual report

Tracking work-related asthma in Michigan

2012 ANNUAL REPORT TRACKING WORK-RELATED ASTHMA IN MICHIGAN

Work-Related Asthma Surveillance Program

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We sincerely appreciate the commitment of those health care providers who understand the public health significance of diagnosing a patient with an occupational illness, as well as the Michigan employees who took the time to share their experiences about their work and subsequent development of work-related asthma.

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There are many resources available to help employers, employees, health care professionals and others understand more about work-related asthma. Links to these resources can be found at: **www.oem.msu.edu**.

Acronyms

OA Occupational Asthma

AA Work-Aggravated Asthma

POA Possible Occupational Asthma

RADS Reactive Airways Dysfunction Syndrome

LARA MI Department of Licensing & Regulatory Affairs

MIOSHA Michigan Occupational Safety & Health Administration

NAICS North American Industrial Classification System

NIOSH National Institute for Occupational Safety & Health

PEL Permissible Exposure Limit

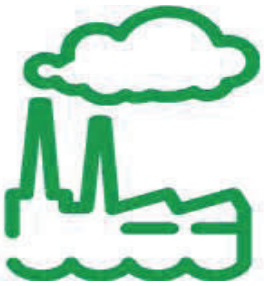
REL Recommended Exposure Limit

This report was funded by the National Institute for Occupational Safety & Health, under cooperative agreement U60-OH008466.

Summary

This is the 22nd annual report on work-related asthma (WRA) in Michigan.

In 2010, in a publication in the Journal of Asthma, researchers found that in a random sample of Michigan adults 54.1% self-reported that their asthma was caused or aggravated by their work, and yet only 22% reported having a discussion with their health care provider about their concern about the effect of work on their asthma[1]. These same individuals were more symptomatic and had more health care usage than other Michigan adults with asthma. This study highlights the importance of health care providers considering whether their patients with asthma have work-related triggers.



There are over 300 known asthma-causing agents used in the workplace. Thousands more substances have not been evaluated for their asthma-causing potential. The Association of Occupational & Environmental Clinics (AOEC) has a web site with an on-line look-up feature to identify asthma-causing agents. http://www.aoecdata.org/ExpCodeLookup.aspx

Part 56 of the Michigan Public Health Code requires reporting of all known or suspected occupational illnesses or work-aggravated health conditions to the Michigan Department of Licensing & Regulatory Affairs *within 10 days of discovery*.

Summary, continued...

- Since 2006, the number of cases identified each year has been less than the overall average of 141.
- From 1988-2012, 3,188 WRA cases have been identified through the MI tracking system.
- We estimate there are 65,000-97,000 adults in MI with WRA.
- 83% of the MI WRA patients have new-onset asthma; 17% have pre-existing asthma aggravated by an exposure at work.
- MIOSHA enforcement inspections at the workplaces where an individual with WRA was reported revealed that, on average, one out of every six of their fellow workers has asthma or respiratory symptoms compatible with asthma.
- Isocyanates-12.5%, and cleaning agents- 11.5%, are the most commonly reported exposures causing WRA in MI.
- About 1% of the MI workforce is employed in manufacturing where isocyanates are used.
- The average incidence rate of WRA among African Americans is 1.5 times greater than that of Caucasians.

Background

In 1988, the State of Michigan instituted a tracking program for WRA with financial assistance from NIOSH. This is a joint project of MIOSHA (LARA) and Michigan State University (MSU), Department of Medicine, Division of Occupational and Environmental Medicine.

The reporting of an index patient is a sentinel health event that may lead to the identification of employees from the same facilities who are also at risk of developing asthma or who have developed similar breathing problems. The goal is to prevent WRA through the identification and workplace follow-up of these index patients.

Work-Related Asthma Tracking Procedures...

Patients are identified through mandatory reporting of any known *or suspected* occupational illnesses, including WRA.

SOURCES TO IDENTIFY PATIENTS

- **Health Care Providers** Private practice, working for industry
- **Hospitals** ICD-9 506.0-.9 & 493, workers' compensation payer
- **Workers' Compensation Agency**
- **Poison Control Center**
- **Reports from Co-Workers or MIOSHA Field Staff** confirmed by a health care provider
- **Death Certificates**
- **Clinical Laboratories for specific IgE Allergy Testing**

WRA Tracking Procedures in Michigan

IDENTIFY PATIENTS

- **Review OD Reports**
  -Submitted to LARA
- **Known or Suspected**
  -Work-Related Asthma
- **Letter to Patient**

INTERVIEW PATIENTS

- **Telephone Interview**
  -Medical and work history
- **Obtain Medical Records**
  -Breathing test results
- **Physician Review**

WORKPLACE INSPECTION

- **Inspection Referral**
  -MIOSHA determines inspection type
- **On-Site Inspection**
  -Assess exposures, conduct air monitoring
  -Injury & Illness Log
  -MSU interviews workers
  -Evaluate medical program

FOLLOW UP ACTIVITIES

- **Inspection Results**
  -Company
  -Workers
  -Reporting Physician
- **Letters to Individual Co-Workers**
  -See doctor if breathing problems reported during interview
- **Analyze Data**
  -Annual Report
  -Other outreach & educational materials

INTERVIEW PATIENTS

A telephone interview with the suspected WRA patient is conducted, and medical records are obtained, including any pulmonary function test results. A board-certified internist and occupational medicine physician reviews all collected information.

WORK-RELATED ASTHMA REQUIRES

A) Physician diagnosis of asthma.

B) Onset of respiratory symptoms associated with a particular job that resolve or improve away from work.

C) Work with a known allergen, or an association between work exposure and a decrease in pulmonary function.

THESE ARE THE SUBCATEGORIES OF WRA

New Onset

1) Occupational Asthma (OA) if A), B), and C) are met.
2) Possible WRA (POA) if only A) and B) are met.
3) Reactive Airways Dysfunction Syndrome (RADS) if symptoms develop after an acute exposure.[2]

Exacerbation

4) Work-Aggravated Asthma (AA) if had asthma in the 2 years prior to job, but asthma worsens at work.

A study of Michigan asthma patients found that as much as 54% of adult asthma was caused or aggravated by exposures in their job.

Workplace Inspections

Welding activities expose workers to heated metal fume, as well as surface contaminants such as oils or dirt and dust.

83% of WRA in Michigan is new onset; 17% is pre-existing asthma aggravated by exposure to an allergen or trigger at work.

After the patient interview is completed and the work-relatedness is determined, a MIOSHA workplace enforcement inspection may be conducted.

During an Inspection:

- Co-workers are interviewed to determine if other individuals are experiencing similar breathing problems from exposure to the allergen.
- Air monitoring for any suspected allergens is conducted.
- The company's health and safety program is reviewed.

After the investigation is complete, a report of air sampling results and any recommendations is sent to the company and made available to workers. A copy of the report is also sent to the reporting physician.

OTHER FOLLOW UP ACTIVITIES

Outreach, educational activities, and recommendations may be developed based on the findings. An annual report summarizing the activity is completed each year.

Results

The following sections report the cumulative results of WRA surveillance from 1988 to date.

REPORTS

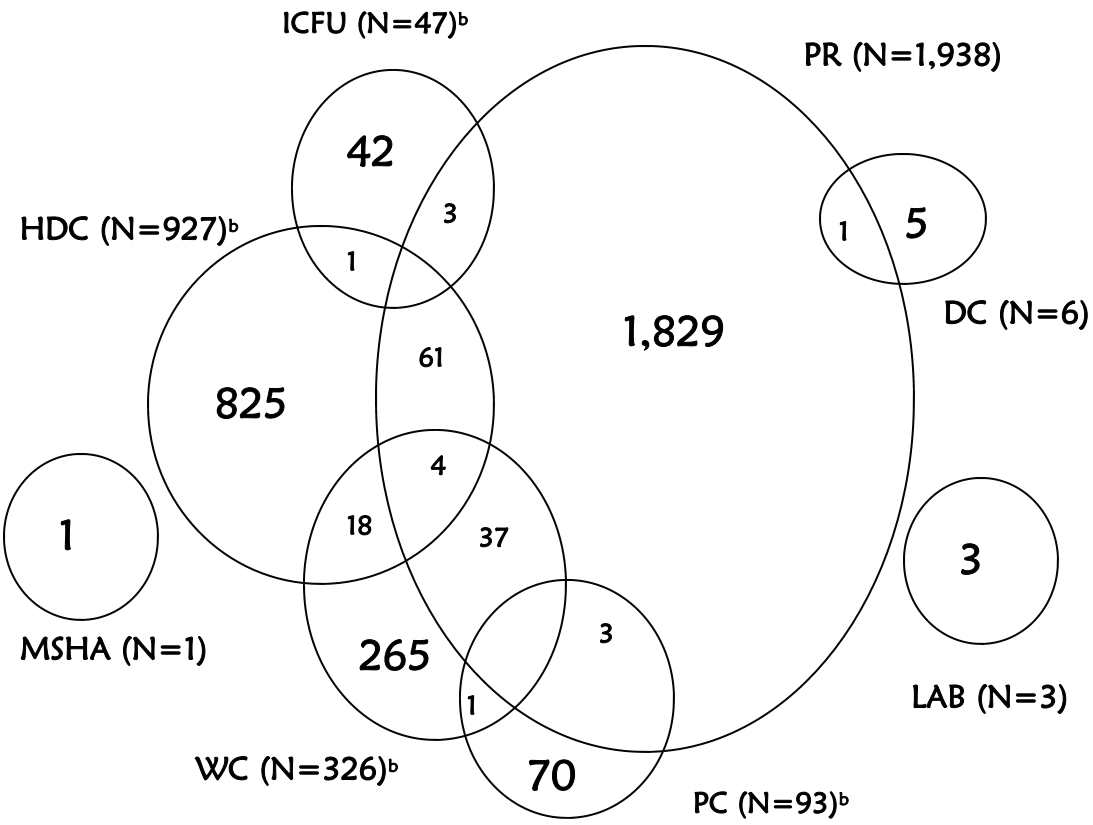
Table 1 shows that 3,188 people were confirmed with WRA between 1988—2012. The reports are divided into: occupational asthma (OA), possible occupational asthma (POA), aggravated asthma (AA) and Reactive Airways Dysfunction Syndrome (RADS). Eighty-six additional patients have been confirmed since last year's report. Figure 1 shows the overlap of the patients by reporting sources for 1988—2012.

TABLE 1
Number of Confirmed Cases of Work-Related Asthma by Year and Type

	Disease Status				
YEAR	OA	POA	AA	RADS	TOTAL
1988	23	7	0	1	31
1989	43	12	3	5	63
1990	87	35	14	8	144
1991	55	30	14	16	115
1992	82	36	14	18	150
1993	75	69	13	19	176
1994	65	59	15	13	152
1995	57	34	19	17	127
1996	61	59	24	11	155
1997	53	74	19	16	162
1998	46	74	18	9	147
1999	48	65	16	12	141
2000	49	67	31	17	164
2001	50	51	20	19	140
2002	39	59	24	21	143
2003	29	64	28	23	144
2004	38	62	37	30	167
2005	42	67	21	23	153
2006	34	61	29	14	138
2007	20	41	34	28	123
2008	16	53	25	16	110
2009	19	42	31	8	100
2010	16	41	30	16	103
2011	16	29	18	3	66[a]
2012	15	18	32	9	74[a]
Total	1,078	1,209	529	372	3,188

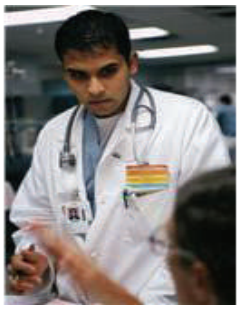
[a]Reports are still being processed for calendar years 2011 and 2012; an increase in these totals will be reflected in next year's annual report.

FIGURE 1
Overlap of Reporting Sources for 3,188 Confirmed Work-Related Asthma Patients: 1988-2012[a]



[a] Ns represent the total number for that source.
Reporting Source: HDC=Hospital Discharge; PR=Physician Referral; DC=Death Certificate; WC=Workers' Compensation; ICFU=Index Case Follow-Up; MSHA=Mine Safety & Health Administration; PC=Poison Control Center; LAB= Laboratory IgE.

[b] There was an overlap of PC-HDC for 17 individuals and of one individual for PC-ICFU, and WC-PC-HDC for one individual each.



Doctors are the most frequent reporters of workers with occupational diseases.

The sooner an individual with WRA is diagnosed and removed from the agent associated with their asthma, the better the prognosis for improvement in symptoms.

Demographics

GENDER

- Women 1,714, 54%
- Men 1,474, 46%

YEAR OF BIRTH

- Range 1905—1995
- Average 1957

RACE

- Caucasian 2,376, 77%
- African American 587, 19%
- Hispanic 63, 2%
- Alaskan/American Ind. 24, 1%
- Asian 14, <1%
- Other 34, 1%
- Unknown 90

ANNUAL INCIDENCE RATE

- African American 3.30
- Caucasian 2.22

The annual incidence rate for African Americans is 1.5X greater than that of Caucasians (95% CI 0.91, 2.41).

Numerator is the average number of WRA cases by race for 2006-2010 reporting years. Denominator Source: American Community Survey Civilian Labor Force by Race in MI, 2006-2010.

Location in State

Table 2 and Figure 2 show the annual average incidence rates of WRA among the working population, by county. The highest rates were in Luce (12.5 cases per 100,000), Clare (11.4 cases per 100,000), Osceola (7.2 cases per 100,000), Cheboygan (7.0 cases per 100,000), Tuscola (6.3 cases per 100,000), Sanilac (6.0 cases per 100,000) and Genesee (6.0 cases per 100,000).

TABLE 2
Average Annual Incidence Rates of Work-Related Asthma Among Michigan Workers by County of Exposure: 1989-2010[a]

County	# EE's[b]	Avg Annual Inc Rate[c]	Cases 1989-2010	County	# EE's[b]	Avg Annual Inc Rate[c]	Cases 1989-2010
Alcona- Iosco	11,850	2.3	6	Isabella	28,625	2.5	16
Alger	3,375	1.3	1				
Alpena	14,400	3.5	11	Jackson	62,700	3.1	43
Antrim	5,975	1.5	2	Kalamazoo-Calhoun-Van Buren	212,700	1.9	88
Arenac	4,950	3.7	4	Kent-Ottawa-Muskegon-Allegan	583,700	1.6	205
Baraga	3,950	3.5	3	Lake	1,950	4.7	2
Barry	13,150	1.7	5	Luce	2,550	12.5	7
Berrien	72,100	1.7	27	Mackinac	5,600	1.6	2
Branch	15,375	5.9	20	Manistee	8,350	1.1	2
Cass	11,150	1.6	4	Marquette	28,450	3.2	20
Charlevoix	11,600	2.4	6	Mason	11,400	1.2	3
Cheboygan	8,475	7.0	13	Mecosta	13,500	1.3	4
Chippewa	15,775	1.2	4	Menominee	9,775	0.5	1
Clare	7,975	11.4	20	Montcalm	20,475	3.1	14
Clinton-Eaton-Ingham	234,600	2.5	130	Montmorency	2,400	5.7	3
Crawford	4,750	4.8	5	Newaygo	10,975	5.0	12
Delta	16,100	1.7	6	Oceana	7,450	1.8	3
Dickinson	14,825	3.4	11	Ogemaw	6,625	5.5	8
Emmet	16,950	1.3	5	Osceola	8,200	7.2	13
Genesee	175,000	6.0	232	Otsego	11,650	3.5	9
Gladwin	5,225	1.7	2	Roscommon	6,700	4.7	7
Gogebic	6,675	1.4	2	Sanilac	13,650	6.0	18
Grand Traverse-Benzie-Kalkaska-Leelanau	63,700	2.2	31	Schoolcraft	2,950	1.5	1
				Shiawassee	20,450	1.3	6
Gratiot	15,000	3.3	11	St. Joseph	25,725	1.8	10
Hillsdale	16,575	3.3	12	Tuscola	15,150	6.3	21
Houghton-Keweenaw	15,975	2.3	8	Washtenaw-Lenawee-Livingston	277,500	3.7	224
Huron	14,750	5.5	18	Wexford-Missaukee	18,800	1.9	8
Ionia	16,575	3.0	11	Saginaw-Bay-Midland	181,500	3.7	149
Iron	4,225	3.2	3	Detroit, MSA[d]	2,151,000	3.1	1,475
				All Michigan Counties[e]	**4,566,000**	**2.9**	**2,947**

[a] 1989 through 2010 represent complete years of reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2011 and 2012 is not yet complete. Therefore, 1988, 2011 and 2012 reports are not included in this table.

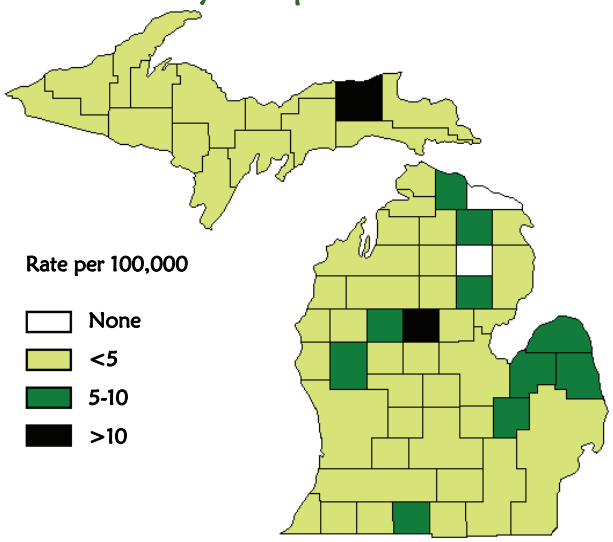
[b] Source: MDCD/Employment Service Agency 1999 Annual Average Labor Statistics for Employment by Place of Work. Some employee population data is only at a multi-county level, as indicated (i.e., not available at a single county level). Therefore, some data is presented with grouped counties.

[c] Rates are based on the average number of cases per year from 1989-2010, per 100,000 Michigan workers.

[d] MSA=Metropolitan Statistical Area and includes Lapeer (31 cases), Macomb (267 cases), Monroe (27 cases), Oakland (382 cases), St. Clair (51 cases) and Wayne (717 cases) counties.

[e] Forty-eight cases had an out-of-state exposure and 22 had an unknown county of exposure, for the 1989-2010 reporting period.

FIGURE 2
Average Annual Incidence Rate of WRA by County of Exposure: 1989-2010[a]



[a] 1989 through 2010 represent complete years of reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2011 and 2012 is not yet complete. Therefore, 1988, 2011 and 2012 reports are not included in this figure.

Type of Industry

Table 3 shows the Michigan industries by NAICS codes, where the exposures to occupational allergens occurred from 1988 to 2012. The predominant industries were in manufacturing (59%) and health care and social assistance (12%).

The incidence rate of WRA by industry type ranges from 0.1 cases per 100,000 in utilities and management of companies to a high of 9.9 cases per 100,000 in manufacturing. Industries with the next highest annual average incidence rates were: mining with 5.9 cases per 100,000 workers and health care and social assistance with 3.4 cases per 100,000 workers.

Table 4 shows the average annual incidence rates for WRA cases *within manufacturing*.

TABLE 3
Number of Work-Related Asthma Patients, 1988-2012 by Primary Industrial Exposure and Annual Average Incidence Rate per 100,000 Workers, 1989-2010

2002 North American Industry Classification System		WRA Cases 1988-2012		Number of Employees[a]	Ann. Average Incidence Rate[b]	
		#	%		Rate	# Cases
11	Agriculture, Forestry, Fishing, & Hunting	19	0.6	81,664	1.0	18
21	Mining	12	0.4	9,300	5.9	12
22	Utilities	15	0.5	861,200	0.1	12
23	Construction	82	2.6	206,100	1.7	77
31-33	Manufacturing	1,883	59.1	823,100	9.9	1,797
42	Wholesale Trade	38	1.2	180,400	0.9	36
44-45	Retail Trade	86	2.7	548,800	0.7	82
48-49	Transportation & Warehousing	63	2.0	132,000	2.0	58
51	Information	20	0.6	76,000	1.1	18
52	Finance & Insurance	26	0.8	154,800	0.6	22
53	Real Estate & Rental & Leasing	16	0.5	55,500	1.2	15
54	Professional, Scientific & Technical Services	26	0.8	268,000	0.4	26
55	Management of Companies & Enterprises	1	<0.1	69,100	0.1	1
56	Administrative & Support & Waste Management	61	1.9	267,000	0.9	54
61	Educational Services	142	4.5	423,300	1.4	135
62	Health Care & Social Assistance	381	12.0	482,700	3.4	358
71	Arts, Entertainment & Recreation	26	0.8	61,500	1.6	21
72	Accommodation & Food Services	89	2.8	332,700	1.2	85
81	Other Services (except Public Administration)	68	2.1	176,900	1.7	65
92	Public Administration	122	3.8	685,000	0.7	113
00	Unknown	12	0.4	--	--	12
Total		3,188	100.1[c]	4,645,864	3.0	3,017

[a]Source: Non-Agriculture: MDLEG Bureau of Labor Market Information & Strategic Initiatives: Michigan Current Employment Statistics 2001. Agriculture: 2002 U.S. Census of Agriculture-State Data. Selected Operator Characteristics by Race: 2002.

[b]Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2011 and 2012 is not yet complete. Therefore, 1988, 2011 and 2012 reports are not included in the calculation of the annual average incidence rate.

[c]Percentage does not add to 100 due to rounding.

Workers can be exposed to sensitizing agents *in any type* of industry.

TABLE 4
1,797 Work-Related Asthma Cases from Manufacturing Industries: 1989-2010[a]

	2002 North American Industry Classification System	WRA Cases #	Ann Avg Rate[a]	# Employees[b]
311	Food Mfg	57	7.8	33,400
323	Printing & Related Support Activities	18	3.7	21,900
325	Chemical Mfg	94	12.3	34,600
326	Plastics & Rubber Products Mfg	99	9.8	45,800
327	Nonmetallic Mineral Product Mfg	16	3.9	18,500
331	Primary Metal Mfg	64	9.3	31,400
332	Fabricated Metal Product Mfg	99	5.1	89,000
333	Machinery Mfg	137	7.0	89,600
334	Computer & Electronic Product Mfg	12	2.3	23,700
336	Transportation Equipment Mfg	1,073	15.4	317,000
337	Furniture & Related Product Mfg	12	1.5	36,900
	Miscellaneous Mfg (*includes NAICS: 312-16,321-322,324,335,339)	116	6.6	79,400

[a]Average annual incidence rate, based on cases from 1989-2010 per 100,000 adult workers in each industrial category, and represents years with complete reporting. Reporting in 1988 was begun mid-year and is incomplete. Reporting for 2011 and 2012 is not yet complete. Therefore, 1988, 2011 and 2012 reports are not included in this table.
[b]Source: MDLEG Bureau of Labor Market Information & Strategic Initiatives: Michigan Current Employment Statistics 2001.

Type of Exposure

Table 5 shows the exposures associated with WRA among Michigan workers. The most frequent exposures reflect the importance of the vehicle manufacturing industry in the State, and the widespread use of cleaning products across all industry sectors. Most frequently identified exposures include: isocyanates (MDI, TDI, HDI and others) accounting for 397 (12.5%) of the WRA case exposures and cleaning products, associated with 368 (11.5%) of Michigan's WRA patients. Metal working fluids (coolants) accounted for 313 (9.8%) of Michigan worker exposures.

There is ongoing interest in ingredients in cleaning products that can cause new-onset asthma and aggravate existing asthma. These products, used both in the home and in all industry sectors (services, manufacturing, etc.) can contain disinfectants, often in the form of quaternary amines, which have been repeatedly shown to cause asthma among workers who either use them or are in the area when they are being used.

Welding is the fifth most common cause of work-related asthma in Michigan. Both welders themselves as well as individuals who work in the same area may be affected by welding fume. A 2011 publication highlights the morbidity and high health care costs from asthma associated with welding[3].

The Michigan WRA Tracking Program has developed a brochure on the hazards of cleaning agents. It is available at: www.oem.msu.edu, and can be found under the **Resources Section.**

TABLE 5
Top Work Place Exposures Associated with Confirmed WRA Patients: 1988-2012

Exposure Agent	#	%
Isocyanates	397	12.5
Cleaning Solutions	368	11.5
Metal Working Fluids	313	9.8
Unknown (Mfg.)	238	7.5
Unknown (Office)	192	6.0
Exhaust/Smoke/Fumes	162	5.1
Welding Fume-Stainless & Other	141	4.4
Solvents	112	3.5
Paint Fumes	77	2.4
Epoxy	70	2.2
Formaldehyde	66	2.1
Fungus	66	2.1
Latex/Rubber	61	1.9
Acids	59	1.9
Chlorine	48	1.5
Plastic Fumes	43	1.3
Fire	42	1.3
Acrylates	38	1.2
Chemicals Used in Construction	37	1.2
Cobalt	30	0.9
Animal Dander	26	0.8
Wood Dust	26	0.8
Flour	26	0.8
Ammonia	24	0.8
Fragrances	24	0.8
Styrene	23	0.7
Cigarette Smoke	20	0.6
Herbicide/Pesticide	20	0.6
Aldehydes	18	0.6
Fiberglass	18	0.6
Chromium	14	0.4
Caustics	13	0.4
Cement Dust	13	0.4
Amines	12	0.4
Grain Dust	12	0.4
Printing Inks	12	0.4
Rust Inhibitor	12	0.4
Cosmetology Chemicals	11	0.3
Medication	11	0.3
Anhydrides	11	0.3
Plants/Organic Matter	9	0.3
Asphalt	8	0.3
Fire Extinguisher Powder	8	0.3
Insecticides	8	0.3
Meat Wrapper's Asthma	8	0.3
Other[a]	241	7.6
Total	**3,188**	**100.2[b]**

[a]There were 6 cases each w/exposure to: Azodicarbonamide, Heat, Nitrogen, Paper Dust, Pickling Ingredients, Sewage, Sulfur Dioxide.

There were 5 cases each w/exposure to: 1,1,1 Trichloroethane, Enzymes, Photo Developing Fluids, Polyurethane, Solder Fume, Textile Lint.

There were 4 cases each w/ exposure to: Asbestos, Coal Dust, Drywall Dust, Freon, Mold Release Spray, Rose Hips, Sulfonate, Tar Fume, Trichloroethylene, X-Ray Developing Fluids.

There were 3 cases each w/exposure to: Cadmium Solder, Colophony, Copier Toner, Dimethyl Benzyl Ammonium Chloride, Glaze, Hydraulic Oil, Kerosene, Lime Dust, Natural Gas, Nickel, Polyethylene, Sand, Sludge, Zinc Oxide.

There were 2 cases each w/exposure to: Acetates, Ammonium Chloride, Cellulose, Cold Air, Concrete Sealer, Copper Oxide, Exercise, Explosion, Fireproofing Chemicals, Gas and Oil Refinery Exposures, Methamphetamine Lab, Ozone, Pepper Gas, Perchloroethylene, Phosgene, Polyester, Polyvinyl Butyrate, Sulfite, Teflon, Zinc.

There was 1 case each w/exposure to: 1,3,Dichloro-2-Propanol, 1,3 Dichloro 5 5-Dimethyl Hydrantoin, Ammonium Bifluoride, Anesthesia, Benzoate Esters, Blood, Blue Prints, Capsaicin, Car Window Sealant, Ceramic Powder, Cooking Oil, Crude Oil, Cyanide, Deck Stain, Dry Ice, Ethylene Oxide, Fertilizer, Flares, Flux, Gortex, Heated Polyvinyl Chloride, Iodine, Isopropyl Alcohol, Methanol, Mica, Monoammonium Phosphate, Ninhydrin, Nylon-polyhexamethylene Adipamide, Odor, Phenol, Pigment, Plasma Cutting, Plating Chemicals, Platinum, Potassium Aluminum Fluoride, Polybutadiene, Raw Coffee Beans, Soda Ash, Sodium Chlorite, Soot, Stress, Swimming Pool Shock, Talcum Powder, Tuberculosis Vaccine, White Lithium, World Trade Center Exposure, Zinc Borate.

[b]Percentage does not add to 100 due to rounding.

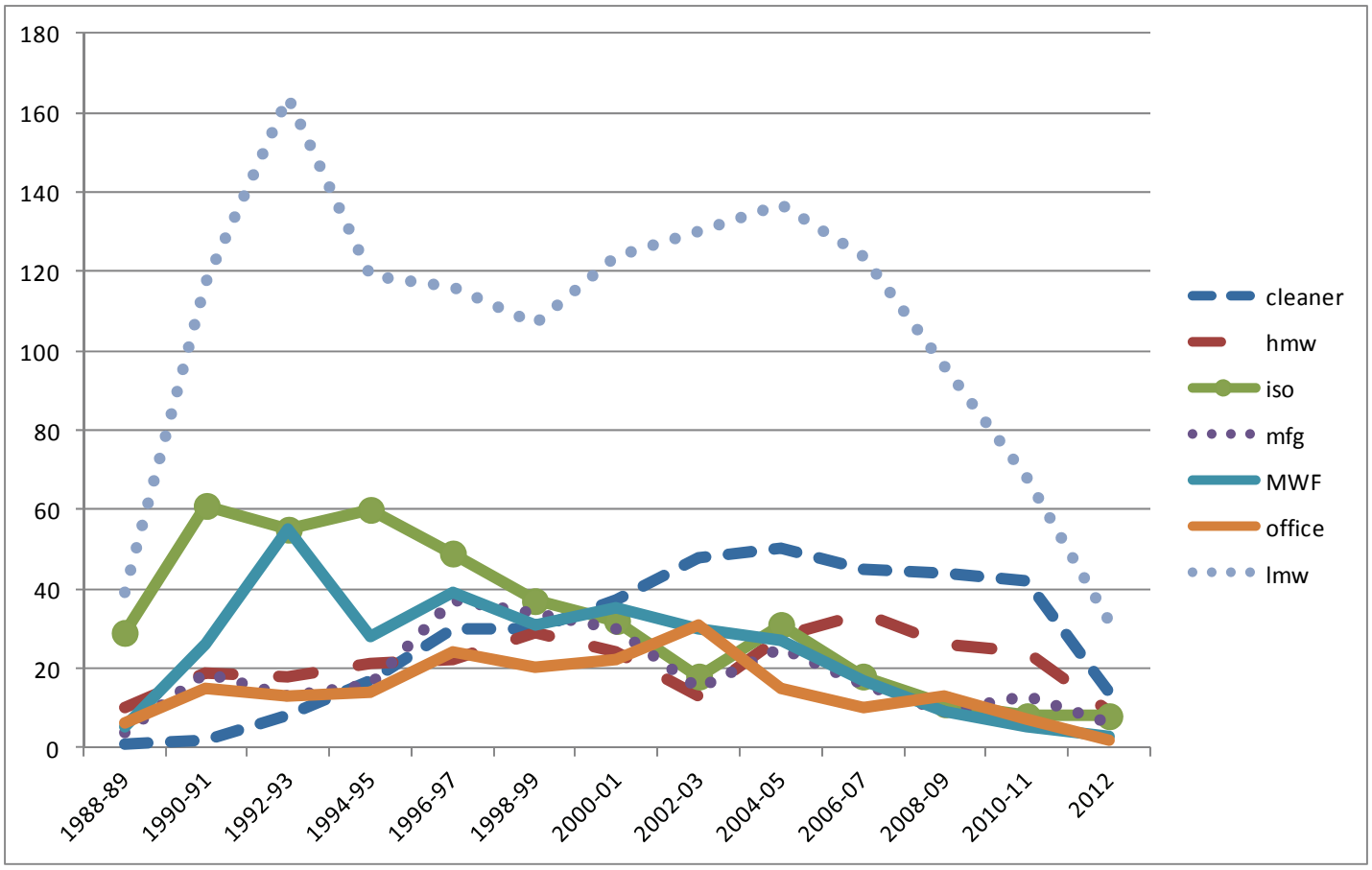
Type of Exposure, continued...

EXPOSURE TRENDS

Figure 3 shows the number of individuals with work-related asthma by type of exposure from 1988-2012. Trends are shown for the five most common causes of WRA and all other exposures that could be grouped as either low molecular weight (i.e. chemicals, metals) or high molecular weight (i.e. organic material, plant or animal) agents. The data is grouped into 2-year time categories to give more stability to smaller numbers of cases in a single year. The number of individuals with WRA caused by diisocyanates, metal-working fluids and other chemicals with low molecular weights appears to be trending downward. Office and animal or plant products with high molecular weights appear unchanged and cleaning agents appear to be trending upward.

FIGURE 3

WRA Patients by the Five Most Common Types of Exposures* and All of the Other High and Low Molecular Weight Compounds, Trend by 2-Year Time Periods: 1988-2012



*Cleaner=cleaning agents, hmw=high molecular weight agents, iso=diisocyanates, mfg=manufacturing agents, MWF=metal working fluids, office=office exposures, lmw=low molecular weight agents.

Medical Results

The percentage of Michigan adult smokers has varied over time, from a high of 28.4% in 1998, to a low of 20.5% in 2010, and an increase in 2011 to 23.3%.

SMOKING STATUS

Table 6 shows patients' cigarette smoking status. Twenty percent of patients were smoking when their asthma developed. This is slightly lower than the state average (23.3%) and markedly lower than that found in blue collar working populations.

ALLERGIES AND ASTHMA

Forty-four percent of WRA patients had a family history of allergies (data not shown).

Fifteen percent of the asthma patients had a personal history of allergies and asthma (Table 7). Forty-eight percent had no history of allergies or asthma.

HEATH CARE USAGE

Sixty-four percent of the WRA patients had at least one visit to the Emergency Department in their lifetime, and 35% had at least one hospitalization for their work-related asthma (Table 8). The average number of ED visits was 5.7 and the average number of hospitalizations was 3.9.

TABLE 6
Cigarette Smoking Status of 3,087[a] Confirmed WRA Patients: 1988-2012

	Smoking Status						
	Current		Ex-Smoker		Non-Smoker		TOTAL
	#	%	#	%	#	%	
OA	221	20.9	414	39.1	423	40.0	1,058
POA	179	15.2	487	41.3	513	43.5	1,179
AA	102	20.7	140	28.5	250	50.8	492
RADS	101	28.2	134	37.4	123	34.4	358
All	603	19.5	1,175	38.1	1,309	42.4	3,087

[a]Missing data on 101 patients.

TABLE 7
Personal History of Allergies or Asthma Among 2,913[a] Confirmed WRA Patients: 1988-2012

	Personal History of...							
	Allergies & Asthma		Asthma		Allergies		No Allergies or	
	#	%	#	%	#	%	#	%
OA	54	5.4	48	4.8	299	29.8	601	60.0
POA	77	7.0	53	4.8	381	34.5	594	53.8
AA	279	55.8	194	38.8	11	2.2	16	3.2
RADS	18	5.9	34	11.1	74	24.2	180	58.8
All	428	14.7	329	11.3	765	26.3	1,391	47.8

*Missing data on 275 patients.

TABLE 8
Health Care Usage Among Confirmed WRA Patients: 1988-2012

Lifetime History of Health Care Usage			
ED Visit[a]		Hospitalized[b]	
Yes	No	Yes	No
# (%)	# (%)	# (%)	# (%)
1,929 (64)	1,065 (36)	996 (35)	1,860 (65)
Range		Range	
1-300 visits		1-200 hospitalizations	
AVG 5.7 ±15.2		AVG 3.9±10.4	

[a]Missing data on 194 patients.
[b]Missing data on 332 patients.

SYMPTOMS

Two thousand five hundred eighty-three of the patients with WRA had persistence of their asthma symptoms (Table 9). Higher percentages of those *still exposed* continued to have breathing problems and take asthma medicine compared to those *no longer exposed*. Higher percentages of those *no longer exposed* had improved breathing and were taking less medicine.

Medical Results, continued...

OBJECTIVE MEDICAL TESTING

The percentage of WRA patients who had different types of pulmonary function testing was:

- Pre-post bronchoprovocation 55%
- Methacholine challenge 20%
- Peak flow monitoring at work & home 3%
- Pre-post work-shift 3%
- Specific antigen challenge <1%

Workplace Investigations

WORKERS' COMPENSATION

About half of the WRA patients applied for workers' compensation benefits; about a third of those who applied for benefits were awarded compensation for their breathing problems.

- Applied 49%....among those who applied:

  Pending approval 47%
  Received benefits 36%
  Denied benefits 17%

TABLE 9
Persistence of Symptoms and Medication Use in 2,914 Confirmed WRA Patients: 1988-2012

Still Exposed?	Total	Breathing Problems Still Present? Yes #	Yes %	Less #	Less %	Still Taking Asthma Medications? Yes #	Yes %	Less #	Less %
Yes	850	817	96.1	252	29.6	736	86.6	155	18.2
No	2,064	1,766	85.6	994	48.2	1,635	79.2	594	28.8
Total	2,914[a]	2,583		1,246		2,371		749	

[a]Information missing on 274 individuals.

INDUSTRIAL HYGIENE

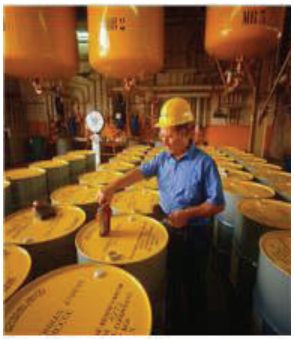
A total of 768 workplace inspections have been conducted since 1988 (Table 10); 122 of those facilities had been inspected more than once. Eight inspections have been completed since last year's report.

Air sampling for allergens was conducted during 553 inspections (Table 11); 26 (4.8%) of the 546 facilities with a MIOSHA standard for the allergen were above the enforceable permissible exposure limit.

TABLE 10
Status of Facilities Where Confirmed WRA Patients Were Exposed to Allergens: 1988-2012

Inspection Status	# Patients Represented	Companies #	Companies %
Inspected	1,206	768[a]	33.6
No Follow-up Planned	1,777	1,331	58.1
Scheduled for Inspection	5	5	0.2
Out of Business	71	63	2.8
No Longer Use Occupational Allergen	27	26[b]	1.1
Sent Company Letter to Check Exposures[d]	102	96	4.2
Total	3,188	2,289[c]	100.0

[a]768 inspections were conducted in 646 different workplaces.
[b]Eight companies that no longer use the allergen were previously inspected.
[c]Represents 2,167 different facilities.
[d]The company was sent information on how to address potential exposures including indoor air issues in their workplace that may be causing respiratory health problems.



Many substances have no method for air monitoring or have not been evaluated for their asthma-causing potential.

TABLE 11
Air Monitoring Results from 768 Workplace Inspections: 1988-2012

Air Sampling – NIOSH Standard	#	%
Above NIOSH Standard	66	8.6
Below NIOSH Standard	461	60.0
No NIOSH Standard	27	3.5
Unknown (no report yet)	5	0.7
Did Not Sample for an Allergen	26	3.4
Did Not Sample	183	23.8
Total	768	100.0

Air Sampling – MIOSHA Standard	#	%
Above MIOSHA Standard	26	3.4
Below MIOSHA Standard	520	67.7
No MIOSHA Standard	7	0.9
Unknown (no report yet)	5	0.7
Did Not Sample for an Allergen	27	3.5
Did Not Sample	183	23.8
Total	768	100.0

AIR MONITORING

Table 12 shows the allergens that were above the NIOSH and/or MIOSHA limits. The top four allergens found to be above the NIOSH REL were:

- Formaldehyde
- Styrene
- Cobalt
- Metal Working Fluids

The top four allergens found to be above the MIOSHA enforceable PEL were:

- Welding Fume
- Styrene
- Cobalt
- Glutaraldehyde

Workers exposed to asthma-causing agents BELOW permissible limits are developing work-related asthma.

TABLE 12
Allergens Above the MIOSHA Permissible Exposure Limit (PEL) and/or NIOSH Recommended Exposure Limit (REL): Michigan 1988-2012

	Above NIOSH REL		Above MIOSHA PEL	
Asthma-Causing Agents	#	%	#	%
Formaldehyde	28	43.8	1	4.0
Cobalt	6	9.4	4	16.0
Styrene	6	9.4	4	16.0
Metal-Working Fluids	5	7.8	1	4.0
Glutaraldehyde	4	6.3	3	12.0
HDI	4	6.3	No PEL	--
MDI	3	4.7	0	--
Wood Dust	3	4.7	2	8.0
Chromic Acid	1	1.6	1	4.0
Ethylene Oxide	1	1.6	0	--
Phthalic Anhydride	1	1.6	1	4.0
Starch	1	1.6	0	--
Total Dust (Dry Plant Materials)	1	1.6	0	—
Welding Fume (Total Particulate)	No REL	--	6	24.0
Flour Dust	No REL	--	2	8.0
TOTAL	64	100.4[a]	25	100.0

[a]Percentages do not add to 100 due to rounding.

Co-Worker Interviews at Workplace Investigations

1 in 6 co-workers of the index patient with asthma reported similar breathing problems in the workplace.

Co-workers were interviewed during 590 of the 768 inspections. Workers had daily or weekly breathing symptoms associated with work or new onset asthma since beginning to work at 385 of the 590 (65%) companies. The average percentage of co-workers with symptoms in these 385 companies was 20.6%. All 1,579 co-workers from the remaining 205 companies reported no daily or weekly breathing symptoms associated with work. One thousand five hundred sixty-five of the 9,996 (15.7%) co-workers interviewed had symptoms consistent with work-related asthma (Table 13).

The MIOSHA Injury and Illness Logs (Form 300) kept by employers listed 578 workers from 132 companies with asthma or asthma-like symptoms. Only nine workers identified in the interviews with daily or weekly chest tightness, shortness of breath or wheezing were also listed on the MIOSHA Log. Combining the information from the interviews and Injury and Illness Log, a total of 2,134 symptomatic workers were identified during the 768 MIOSHA enforcement inspections.

TABLE 13
Breathing Symptoms Among Co-Workers of the 3,188 Confirmed WRA Patients: 1988-2012

	Disease Status of the Index Patient									
Symptoms	ALL		OA		POA		AA		RADS	
	#	%	#	%	#	%	#	%	#	%
Daily or Weekly SOB, Wheezing or Chest Tightness	1,565	15.7	1,100	16.0	421	15.1	6	12.0	38	13.9
Workers Interviewed	9,996		6,888		2,784		50		274	
Workers on OSHA Log	578		400		165		2		11	
# Companies w/Ee on Log	132	17.2	90	20.3	37	13.0	1	7.1	4	15.4
# Companies Inspected	768		444		284		14		26	
Total Workers w/Symptoms[a]	2,143		1,500		586		8		49	

[a]Nine individuals were identified both on the co-worker questionnaire and the OSHA Log.

Limiting asthma management to just the treatment of symptoms is an unacceptable way to manage work-related asthma.

Work-Related Asthma Deaths

Fortunately, a very small percent (0.01-0.02%) of asthma patients die from asthma. From 2003 to 2008, we have identified eight work-related asthma deaths.

There were no work-related asthma deaths identified in calendar years 2009 through 2012.

We have published articles on some of the work-related asthma deaths[4,5].

Michigan Workforce Exposed to Select Causes of WRA

The United States Environmental Protection Agency (EPA) requires reporting by manufacturers, mines or electrical utilities that have at least 10 employees and use any one of 650 different chemicals in amounts greater than 10,000 pounds per year. Queries of reportable chemicals can be generated to identify state-level statistics.

We identified Michigan's isocyanate-using companies in the EPA Toxic Release Inventory (TRI) to estimate the number of workers employed by manufacturers who are potentially exposed to isocyanates, the most commonly reported cause of WRA in Michigan (Table 14). Our estimate under-counts non-manufacturing exposed employees such as those at auto body paint shops because the EPA does not include non-manufacturing establishments. Conversely, our estimate over-counts manufacturing employees because we included the total number of employees at each facility that reported isocyanates, even though not all workers at these facilities would have worked with or around isocyanates.

Another source to identify chemical exposures associated with WRA comes from the Michigan Department of Environmental Quality (DEQ). The chemicals listed in the Michigan Facilities' Guide to SARA Title III, Emergency Planning and Release Reporting (December 2007, 6th edition) are subject to reporting under the Emergency Planning and Community Right-to-Know Act (EPCRA) section 313, triggered by threshold amounts of 25,000 pounds manufactured or processed or 10,000 pounds otherwise used at Michigan facilities.

Unlike the EPA TRI data, all companies must report if they meet the threshold amount of chemical used; there are no limitations to reporting based on the type of facility or the number of individuals employed.

Between the two reporting sources, there were 106 companies that reported the use of at isocyanates in calendar year 2012, which is up from 103 companies in 2011. The number of workers employed in companies that use isocyanates, the total number of workers in these counties, and the percentage of workers who work in facilities where isocyanates are used is listed in Table 14. The 33,659 workers potentially exposed to isocyanates in 2012 is up from the 30,496 potentially exposed in 2011.

Table 15 summarizes the companies, by county, using other chemicals that are known to cause asthma and those that are irritants and capable of causing Reactive Airways Dysfunction Syndrome. Those that can cause asthma are: Cobalt, Epichlorohydrin, Formaldehyde, Methyl Acrylate, Phthalic Anhydride and Styrene. Ammonia and Chlorine are classified as irritants. These companies were identified through the MI DEQ SARA Title III Emergency Planning and Release Reporting for calendar year 2012.

Additional chemical exposures associated with WRA in Michigan can be found at: http://www.oem.msu.edu/userfiles/file/Resources/MichiganWorkforceChemicalReport-with%20agent%20tables.pdf

TABLE 14
Michigan Workers Employed in Manufacturing Facilities Where Isocyanates are Used, by County

County	Company Name[c,d]	# Workers Employed[a] by Isocyanate-Using Facilities	Total # Workers in the County[b]	% Workers Potentially Exposed to Isocyanates
ALLEGAN	HAWORTH INC			
	JOHNSON CONTROLS INTERIORS PMSC	2204	49316	**4.5**
	JOHNSON CONTROLS INTERIORS-MAPLEWOOD FAC			
BARRY	BRADFORD WHITE CORP	1100	27080	**4.1**

Table 14, continued...

County	Company Name[c,d]	# Workers Employed[a] by Isocyanate-Using Facilities	Total # Workers in the County[b]	% Workers Potentially Exposed to Isocyanates
BERRIEN	LECO CORP VAIL RUBBER WORKS, INC.	910	65940	**1.4**
CALHOUN	BOSTIC-MARSHALL CELLO-FOIL PRODUCTS COMCAST URETHANE	223	58923	**0.4**
CHARLEVOIX	EAST JORDAN FOUNDRY	504	11418	**4.4**
CLARE	RENOSOL	300	10665	**2.8**
CLINTON	INNOVATIVE POLYMERS INC	10	34870	**<0.1**
CRAWFORD	WEYERHAUESER	125	5276	**2.4**
DICKINSON	GREDE LOUISIANA-PACIFIC-SAGOLA OSB	580	12281	**4.7**
EATON	AXSON N AMERICA GM LANSING DELTA TWP	1030	50632	**2.0**
GENESEE	ASI PACKAGING COMPANY DELPHI ELECTRONICS & SAFETY FERGUSON BLOCK CO., INC.	1029	166735	**0.6**
HILLSDALE	DOW CHEMICAL	45	17388	**0.3**
INGHAM	HUNTSMAN ADVANCED MATERIALS WILLIAMSTON PRODUCTS INC	190	130731	**0.1**
ISABELLA	DELFIELD CO	550	34309	**1.6**
JACKSON	MICHIGAN SEAT CO MILSCO MICHIGAN SEAT TAC MFG	700	64420	**1.1**
KALAMAZOO	AZON USA DAVID A CHENOWITH ROOFING	60	116115	**0.1**
KENT	GRAND RAPIDS FOAM TECHNOLOGIES HB FULLER LACKS WHEEL TRIM SYSTEMS LEON PLASTICS PURFORMS INC RICHWOOD INDUSTRIES INC	610	290662	**0.2**
LAPEER	NORTH AMERICAN PROCESSING	8	35278	**<0.1**
LENAWEE	ANDERSON DEVELOPMENT CLINTON-PILKINGTON INSULSPAN INTEVA PRODUCTS	735	40143	**1.8**

Table 14, continued...

County	Company Name[c,d]	# Workers Employed[a] by Isocyanate-Using Facilities	Total # Workers in the County[b]	% Workers Potentially Exposed to Isocyanates
LIVINGSTON	ATREUM HOWELL (INTIER AUTOMOTIVE) ATREUM-BRIGHTON	400	80595	**0.5**
LUCE	LOUISIANA-PACIFIC CORP-NEWBERRY SIDING	111	2243	**4.9**
MACOMB	AXALTA COATING SYSTEMS CHRYSLER STERLING HTS ASSY DUPONT MT CLEMENS PLT FAURECIA INTERIOR SYSTEMS INTERNATIONAL CASTING CORP MICHIGAN METAL TECHNOLOGIES PLANT ROMEO RIM ONC SHELBY FOAM SYSTEM WOLVERINE BRONZE	3353	358456	**0.9**
MASON	DUNA-Ludington Plant GREAT LAKES CASTING	244	13218	**1.8**
MECOSTA	WOLVERINE WORLD WIDE	540	18025	**3.0**
MIDLAND	DOW CHEMICAL CO– 1790 BLDG & 1100 BLDG	2000	38846	**5.1**
MONTCALM	AGA MARVEL ELECTROLUX HOME PRODUCTS KENT FOUNDRY	643	22231	**2.9**
MONROE	AUTOLIGN MFG SUNRISE WINDOWS	175	63772	**0.3**
OAKLAND	ARMALY SPONGE BEHR AMERICA CASS POLYMERS OF MI EAGLE INDUSTRIES EXOTIC RUBBER AND PLASTICS COR FANUC ROBOTICS-Corporate Headquarters ITW FUTURA COATING OTTO BOCK POLYURETHANE TECHNOLOGIES RECTICEL INTERIORS N AMERICA RECTICEL UREPP N AMERICA	2415	534471	**0.5**
OGEMAW	TAYLOR BUILDING PRODUCTS	55	8086	**0.7**
OTTAWA	DAKE OEM EAGLE PACKAGING MAGNA-SEALING & GLASS SYSTEMS	440	121070	**0.4**

Table 14, continued...

County	Company Name[c,d]	# Workers Employed[a] by Isocyanate-	Total # Workers in the County[b]	% Workers Potentially Exposed to Isocyanates
SAGINAW	FILTRONA POROUS TECHNOLOGIES GLASTENDER NEXTEER AUTOMOTIVE CORP SAGINAW METAL CASTING OPERATIONS	3040	82690	**3.7**
SANILAC	GRUPO ANTOLIN MIDWEST RUBBER CO NUMATICS SANDUSKY MAIN TRELLEBORG YSH INC	825	17470	**4.7**
ST CLAIR	IAC PORT HURON INTERNATIONAL AUTOMOTIVE COMPONENTS TAKATA PETRI	500	65873	**0.8**
ST JOSEPH	IAC MENDON	600	25285	**2.4**
VAN BUREN	BASF CORP SPECIAL-LITE INC	182	32373	**0.6**
WASHTENAW	COLLINS & AIKMAN PLASTICS EXTANG CORP FAURECIA INTERIOR SYSTEMS	2530	171912	**1.5**
WAYNE	ALPHA RESINS BASF CORP BAY CORP CHRYSLER JNAP CYGNET AUTOMATED CLEANING EFTEC EQ DETROIT (Environmental Quality) PLASTOMER CORP POOF-SLINKY INC RECYCLED POLYMERIC MATERIALS UNIVAR USA/ROMULUS WOODBRIDGE CORP	4689	720899	**0.7**
WEXFORD	REC BOAT HOLDINGS-CRUISER PLANT	4	11817	**<0.1**
TOTAL		**33,659**	**4,232,000**	**0.8**

[a]Source: Michigan Manufacturers' Directory, 2013 and www.acinet.org accessed February 21, 2014.

[b]Source: Michigan Labor Market Information, Data Explorer, www.milmi.org accessed February 21, 2014.

[c]Source: U.S. Environmental Protection Agency. Toxics Release Inventory, Michigan Companies Using Isocyanates in 2012 (report December 23, 2013).

[d]Source: Michigan Department of Environmental Quality, FOIA Request for SARA Title III Emergency Planning and Release Reporting of select chemicals (isocyanates), for calendar year 2012, received January 13, 2014.

TABLE 15

Michigan Facilities by County, Reporting Toxic Chemicals to the Michigan Department of Environmental Quality (DEQ) Under Section 313 of the Emergency Planning and Right–to-Know Act (EPCRA)[a]

SUBSTANCES CAPABLE OF CAUSING ASTHMA:

Cobalt, Epichlorohydrin, Formaldehyde, Methyl Acrylate, Phthalic Anhydride, & Styrene

SUBSTANCES CAPABLE OF CAUSING REACTIVE AIRWAYS DYSFUNCTION SYNDROME:

Ammonia & Chlorine

A=Ammonia, CH=Chlorine, CO=Cobalt, E=Epichlorohydrin, F=Formaldehyde, M=Methyl Acrylate & Methyl Methacrylate (MMA), P=Phthalic Anhydride, S=Styrene

County	Company Name	Type of Exposure
ALGER	NEENAH PAPER - MICHIGAN INC	A
ALLEGAN	Birds Eye Foods LLC	A, CH
	Hamilton Farm Bureau - Hamilton Main	A
	JBS Plainwell, Inc.	A
	Van Elderen Inc.	F
	Water Renewal	CH
	Wayland	CH
ARENAC	Whitestone Pumping Station	CH
BARAGA	CUSTOM COMPOSITES DIVSION	S
BAY	BAY City Municipal Water Treatment Plants	CH
	CROP PRODUCTION SERVICES	A
	Dow Corning Corporation - Auburn Site	A, CH
	ESSEXVILLE WASTEWATER TREATMENT	CH
	MAMMEL, MICHAEL/FARM	A
	Mersen USA BN. Corp.	CH
	QUANTUM COMPOSITES, INC.	S
	WEST BAY COUNTY REGIONAL WASTEWATER	CH
BENZIE	GRACELAND FRUIT, INC.	A
	PLATTE RIVER ST FISH HATCHERY	F
	SMELTZER ORCHARD COMPANY	A
BERRIEN	ADVANCE PRODUCTS CORPORATION	A
	Benton Harbor	A
	BENTON HARBOR WATER PLANT	CH
	BUCHANAN AGRONOMY & PETROLEUM	A
	BUCHANAN WATER & WASTEWATER TREATMENT PLANT	CH
	COLOMA FROZEN FOODS INC	A
	GREG ORCHARDS & PRODUCE INC	A
	HANSON COLD STORAGE-NAPIER & PIPESTONE	A
	LECO CORPORATION	A
	MODAR INC.	F

Table 15, continued...

County	Company Name	Type of Exposure
BERRIEN	NCP COATINGS INC.	A, P
	NEW BUFFALO WATER PLANT	CH
	NILES, CITY - DECKER, FORT & FRONT WELLS & IRON REMOVAL	CH
	Old Europe Cheese, Inc.	A
	SAINT JOSEPH WATER PLANT	CH
	SANDVIK MATERIALS TECHNOLOGY	A
BRANCH	ALERIS SPECIFICATION ALLOYS, INC.	CH
	CONAGRA FOODS INC	A
	STAR OF THE WEST MILLING COMPANY	CH
	WATER TREATMENT PLANT/COLDWATER	CH
CALHOUN	Albion Plant	A
	ANATECH, LTD.	F
	BATTLE CREEK WATER TREATMENT & WWTP	CH
	GUARDIAN FIBERGLASS INC.	F
	HOUSE OF RAEFORD FARMS, INC	A
	MARSHALL CITY WATER	CH
	MUSASHI AUTO PARTS-MICHIGAN INC	A
	Post Foods - Battle Creek	CH
	PRAIRIE FARMS DAIRY, INC.	A
	THE ANDERSONS ALBION ETHANOL, LLC	A
	VERONA PUMPING STATION	CH
CASS	The Mennel Milling Co. of Michigan	CH
CHARLEVOIX	Charlevoix	CH
CHEBOYGAN	CITY OF CHEBOYGAN WELLHOUSE #4 & #7 & WWTP	CH
CHIPPEWA	PENDILLS CREEK	F
	SULLIVAN CREEK	F
CLINTON	Crop Production Services 622	A
	MAHLE ENGINE COMPONENTS USA, INC.	A
	MARTIN BROWER	A
	Michigan Milk Producers Association	A
	SAVE-A-LOT LTD	A
	SCCMUA	CH
	Vanderhoof Farms	A
	Wastewater Treatment Facility	CH
	Williams Farms	A
CRAWFORD	ARCTIC GLACIER INC	A
	GRAYLING GENERATING STATION	CH
	WEYERHAEUSER NR COMPANY	F
DELTA	ESCANABA PAPER COMPANY	A, CH

Table 15, continued...

County	Company Name	Type of Exposure
DICKINSON	Verso Paper Quinnesec	CH
EATON	AXSON NORTH AMERICA INC.	S
	CASS POLYMERS OF MICHIGAN INC	S
	ETM Enterprises Inc.	S
	S.P.KISH INDUSTRIES	A
EMMET	ODEN STATE FISH HATCHERY	F
	Petoskey	CH
GD TRAVERSE	CentreICE	A
	CENTURY SUN METAL TREATING	A
	CHERRY GROWERS INC - GRAWN & TC PLTS	A
	MICHIGAN PLANT	A
	SARA LEE BAKERY	A
	TCS TRAVERSE COLD STORAGE LLC	A
	Traverse City	CH
GENESEE	ANTHONY RAGNONE TREATMENT PLAN	CH
	Cupid Farms	A
	Flint	CH
	FLINT WATER PLANT	CH
	HENDERSON ROAD PUMP STATION	CH
	KELSEY-HAYES COMPANY	CH
	KOEGEL MEATS INC.	A
	Oginsky Farm	A
	STOKES STEEL TREATING COMPANY	A
	Taylor Farms	A
	VanGilder- Malone Farm	A
	WATER POLLUTION CONTROL FACILITY	CH
	Woodworth Inc. Flint	A
GOGEBIC	CITY OF IRONWOOD WATER PUMP ST	CH
GRATIOT	ALMA WASTEWATER PLANT	CH
	CITY OF ST. LOUIS WWTP	CH
HILLSDALE	BEF Foods Inc.	A
	CITY OF OTSEGO WWTP & WELLS #3, #4 & #5	CH
	HILLSDALE WASTEWATER TREATMENT	CH
	PRATTVILLE FERTILIZER & GRAIN, INC.	A
	PRIDGEON FARMS	A
	THE ANDERSONS LITCHFIELD FARM	A
HOUGHTON	MICHIGAN-AMERICAN WATER COMPANY	CH
	Osmose Hubbell	A

Table 15, continued...

County	Company Name	Type of Exposure
HURON	Bad Axe Wastewater Treatment Plant	CH
	CO-OP ELEVATOR ELKTON NH3 SITE	A
	COOPERATIVE ELEVATOR COMPANY - BAD AXE & RUTH	A
	DOW AGROSCIENCES LLC	A
	FARMERS CO-OP GRAIN CO.	A
	HARBOR BEACH WATER WORKS & WWTP	CH
	PORT AUSTIN AREA SEWER & WATER	CH
	THUMB TOOL & ENGINEERING	A
INGHAM	ALDI INC - WEBBERVILLE	A
	ALEXANDER CHEMICAL CORPORATION	A, CH
	AURORA SPECIALTY CHEMISTRIES	E
	CITY OF LESLIE WASTEWATER TREATMENT PLANT	CH
	CREMER FARM CENTER, Inc.	A
	DYE WATER CONDITIONING PLANT	A
	E LANSING-MERIDIAN WATER & SEWER AUTHORITY	A
	HAWKINS, SID/FARM	A
	JORGENSEN FARM ELEVATOR	A
	Lansing Mint Rd.	A
	LANSING PLANTS - EMPIRE WAY & COMMERCE	A, CH
	MASON P.O.T.W. PLANT	CH
	MBI	A
	MEIJER LANSING DISTRIBUTION	A
	NITREX INC - MICHIGAN OPERATION	A
	Pidd Brothers Farm	A
	QUALITY DAIRY COMPANY	A
	RICE, DONALD/FARM	A
	RIVER INTAKE HOUSE	CH
	SYMMETRY MEDICAL INC-LANSING	CO
	THE ANDERSONS WEBBERVILLE AG PRODUCTS	A
	WALNUT VU FARM/FARM	A
	Watters & Sons Farm	A
	WILLIAMSTON WATER TREATMENT DEPT	CH
IONIA	BELDING TANK TECHNOLOGIES, INC	S
	CALEDONIA FARMERS ELEVATOR	A
	Carbon Green BioEnergy	A
	Cargill Kitchen Solutions	A
	CROP PRODUCTION SERVICES	A

County	Company Name	Type of Exposure
IONIA	FARM DEPOT 3 LTD	S
	GALLAGHERS	A
	HENNERY	A
	PORTLAND WWTP	CH
	STAHLIN ENCLOSURES	S
	TRW AUTOMOTIVE US LLC - PORTLAND PLANT	A
	TWIN CITY FOODS	A, CH
IOSCO	HURON SHORE REGIONAL UTILITY A	CH
	ROSE ICE COMPANY	A
	TAWAS UTILITY AUTHORITY WWTP	CH
	TIP-TOP SCREW MFG IN	A
JACKSON	CITY OF JACKSON WATER TREATMENT	CH
	Coventry Park	CH
	INDUSTRIAL STEEL TREATING	A
	JCC Well House	CH
	Kimmel Road well house	CH
	Meadow Heights Well	CH
	SOUTHVIEW PUMP STATION	CH
	SPRINGPORT ELEVATOR INC	A
	TENNECO - JACKSON ENGINEERING FACILITY	A
	Westchester Pump Station	CH
KALAMAZOO	CITY OF KALAMAZOO- STATIONS #28 & #39	CH
	HAVILAND PRODUCTS COMPANY	F
	KALAMAZOO WATER DIV/STA #1-#5, #8, #9, #11, #12, #14, #17, #18, #22, #24, #25, #31	CH
	KLC1	A
	KNAPPEN MILLING CO	CH
	PHARMACIA & UPJOHN LLC - PFIZER INC MFG COMPLEX	A, CH, E, F
	PRECISION HEAT TREATING COMPANY	A
	Thermo Fisher Scientific	F
KENT	ARKEMA INC.	P
	BRENNTAG GREAT LAKES LLC	F
	BUTTERBALL FARMS INC	A
	CHASE STORAGE & CHASE ORCHARDS	A
	Coca-Cola Grand Rapids	A
	ConAgra Foods Grand Rapids	A
	COUNTRY FRESH LLC	A
	Distribution Center #1	A
	Eagles Ice Center	A

Table 15, continued...

County	Company Name	Type of Exposure
KENT	Earthgrains Baking Companies Inc.	A
	Emerald Spa Corporation	S
	FINISHMASTER INC #990 DIST CR	S
	FORTY-FOURTH STREET FACILITY	A
	FRUIT RIDGE APPLE CO	A
	GM COMPONENTS HOLDINGS, LLC	A
	GORDON FOOD SERVICE - CLAY AVE & 50TH ST	A
	GRAND RAPIDS CONTROLS COMPANY LLC	F
	Grand Rapids Edge Ice Arena	A
	Grandville	A, CH
	GRF INDUSTRIES, INC	F
	JACK BROWN PRODUCE INC	A
	KENT QUALITY FOODS INC	A
	KING MILLING COMPANY	CH
	LACKS TRIM SYSTEM - AIRLANE PLANT	F
	LACKS WHEEL SYSTEMS	F
	LOWELL WWTP & WATER TREATMENT & FILTRATION	CH
	MACDONALDS INDUSTRIAL PRODUCTS - PLANT 3	F
	MICHIGAN NATURAL STORAGE CO	A
	MICHIGAN TURKEY PRODUCERS - HALL ST & CHICAGO DR	A
	NBHX Trim USA	S
	NORTH RIDGE ORCHARD LLC	A
	PATTERSON ICE CENTER	A
	REMICO STREET FACILITY	CH, F
	RIDGEKING APPLE PACKING AND STORAGE	A
	RIVERIDGE PACKING	A
	S1	A
	SPARTA FACILITY	A
	SPARTAN STORES DISTRIBUTION	A
	SPECIALTY HEAT TREATING, INC.	A
	STATE HEAT TREATING COMPANY	A
	SUPERIOR SEAFOOD INC.	A
	SUPERIOR STONE PRODUCTS INC	S
	SYSCO GRAND RAPIDS, LLC	A
	UNIVAR USA/GRAND RAPIDS/WYOMING	S
	VI-CHEM CORPORATION	S
	VILLAGE OF SPARTA WATER DEPT	CH

Table 15, continued...

County	Company Name	Type of Exposure
KENT	WYOMING CLEAN WATER PLANT	CH
	YOUNG CHEMICAL COMPANY	F
KEWEENAW	SUSANS BIG DUMMY	A
LAPEER	LAPEER GRAIN EAST	A
	Lapeer Plating & Plastics	F
LEELANAU	LEELANAU FRUIT COMPANY	A
LENAWEE	ADC Main Plant	F, S
	ADC-NF3 PLANT	A
	Airgas Carbonic, Inc	A
	CROP PRODUCTION SERVICES 634 & 641	A
	DAIRY FARMERS OF AMERICA	A
	GREAT LAKES CHEMICAL	A,CH
	War-Ag Farms Services LLC	A
	Wellhouse #3 #8 #9 #10 #11 #12 & #14	CH
	WILBUR-ELLIS COMPANY - MUNSON	A
LIVINGSTON	ALPHA TECHNOLOGY CORPORATION	S
	CHEMCO PRODUCTS, INC.	F
	COR-MET INC	CO
	GORDON FOOD SERVICE	A
	May and Scofield	S
	PEPSI COLA METROPOLITAN BOTTLING	A
	WATER PLANT & WWTP	CH
LUCE	NEWBERRY WWTP	CH
MACKINAC	WATER TREATMENT PLANT & WWTP	CH
MACOMB	BOSCOS PIZZA	A
	CARBIDE TECHNOLOGIES	A
	CHEMTECH FINISHING SYSTEM, INC	E, F
	DU PONT- MT CLEMENS PLANT	F, S
	EVERFRESH / LA CROIX BEVERAGES	A
	FINI FINISH PRODUCTS INC	CH
	FORMSPRAG LLC	A
	GM LLC TECHNICAL CENTER	A
	METALLURGICAL PROCESSING COMPANY	A
	NITRO-VAC HEAT TREATING	A
	NORBROOK PLATING	A
	REINHART FOODSERVICE LLC	A
	SPECIALTY STEEL TREATING, INC.	A
	STEEL PROCESSING COMPANY LLC	A

Table 15, continued...

County	Company Name	Type of Exposure
MACOMB	TI AUTOMOTIVE SYSTEMS	CH
	TURRI'S ITALIAN FOODS, INC	A
MANISTEE	Main	S
MARQUETTE	AIRGAS NORTH CENTRAL INC	CH
	KI SAWYER WWTP	CH
	NEGAUNEE WASTEWATER TREATMENT	CH
MASON	HOUSE OF FLAVORS INC	A
	JOS. SANDERS INC	A
	Ludington Wastewater Plant	CH
	MICHIGAN FOOD PROCESSORS	A
MECOSTA	LEPRINO FOODS COMPANY REMUS	A
	UNITED STATES MARBLE INC.	S
MENOMINEE	L.E. JONES COMPANY	CO
	MENOMINEE WATER TREATMENT PLANT & WWTP	CH
	RULEAU BROS INC	A
MIDLAND	CITY OF MIDLAND - WATER TREATMENT & WWTP	CH
	Dow Corning - Midland Plant	A, CH
	HOMESTEAD TOOL - SMC PLANT	S
	Mersen USA Midland-MI Inc	CH
	Michigan Operations	A, CH, E, S
	Midland Dow, James Savage & BLDG 1612	CH
	Styron LLC - MI Operations	M, S
MONROE	ADVANCED HEAT TREAT CORP	A
	DETROIT EDISON - MONROE POWER PLANT	A
	HOME CITY ICE COMPANY- Toledo	A
	INDEPENDENT DAIRY INC	A
	MAYBEE FARMERS INC	A
	MEIJER NEWPORT DISTRIBUTION	A
	OTTAWA LAKE CO-OP ELEVATOR	A
	ROYSTER-CLARK, INC. 655	A
MONTCALM	Crop Production Services	A
	MUD/DME	A
MUSKEGON	ALLOY RESOURCE CORPORATION	CH
	BAYER CROPSCIENCE USA	A
	COLE'S QUALITY FOODS, INC.	A
	ESCO COMPANY, LLC	P
	GMI Composites, Inc	S
	HOWMET CORPORATION - PLANTS 1, 3, 5 & 10	CO

Table 15, continued...

County	Company Name	Type of Exposure
MUSKEGON	L-3 COMBAT PROPULSION SYSTEMS	A
	LAKE WELDING SUPPLY COMPANY INC	A
	SNAPPY APPLE FARMS INC	A
	SUN CHEMICAL CORPORATION	A
	WEBB CHEMICAL SERVICE CORP INC.	F
NEWAYGO	GERBER PRODUCTS COMPANY	A
OAKLAND	BEHR AMERICA INC	A
	CHEMICAL BLENDING	F
	CHOR INDUSTRIES INC.	A
	COMMERCIAL STEEL TREATING CORP	A
	DEPOR INDUSTRIES	F
	Detroit Skating Club	A
	Detroit Steel Treating Co.	A
	ENGINEERED HEAT TREAT INC	A
	FARMINGTON HILLS ICE ARENA	A
	Ferndale	A, CH
	FOGLERS ORCHARD & FARM MARKET	A
	GENERAL MOTORS PROVING GROUND	CH
	HAZEL PARK VIKING ARENA	A
	JOHN LINDELL ICE ARENA	A
	LAKELAND ARENA	A
	LAKELAND HIGH SCHOOL	CH
	MACDERMID INCORPORATED	F
	MARBELITE CORPORATION	S
	Matheson Valley	A
	NOVI ICE ARENA	A
	ONYX-ROCHESTER ICE ARENA	A
	RMT Woodworth, Southfield	A
	SPECIALTY STEEL TREATING INC	A
	STONE SOAP COMPANY INC	F
	SUBURBAN TRAINING CENTER	A
	SULZER METCO (US) INC	CO
	SUN STEEL TREATING INC	A
	US Foods Inc.	A
	VILLAGE OF HOLLY WWTP	CH
	VILLAGE OF MILFORD IRON REMOVAL PLANT	CH
	WATERFORD IRON REMOVAL PLANT 5-1, 12-1, 14-1, 16-1 & 2, MS-1, 19-1, 24-1, 25-1 & 2, 28-1, 31-1	CH
OCEANA	2nd Street Storage	A

Table 15, continued...

County	Company Name	Type of Exposure
OCEANA	Arbre Farms Corporation	A
	Hart Division	A
	MICHIGAN FREEZE PACK	A
	OCEANA COUNTY FREEZER STORAGE,	A
	PETERSON FARMS MAIN CAMPUS	A
OGEMAW	SANDVIK HARD MATERIALS	CO
OSCEOLA	ADVANCED FIBERMOLDING	S
	DEAN DAIRY HOLDINGS,LLC dba LIBERTY DAIRY COMPANY	A
	VENTRA EVART, LLC	F
	YOPLAIT REED CITY	A
OTSEGO	Gaylord	CH
	JORDAN RIVER NAT FISH HATCHERY	F
OTTAWA	Allendale Plant	A
	B & B FARMS	A
	Beuschel Fruit & Dairy	A
	BOAR'S HEAD PROVISIONS CO INC	A
	County Line Dairy	A
	CREME CURLS BAKERY, INC.	A
	Crisp Hill Dairy Farm	A
	CSD	A
	Dietrich Orchards	A
	Fitzpatrick Farm	A
	GEORGETOWN ICE CENTER	A
	Gerrit VanDenTop Farm	A
	Greenly Street Plant	A
	Gruppen Farms	A
	HUDSONVILLE CREAMERY & ICE CREAM LLC	A
	INTERSTATE WAREHOUSING LLC	A
	J.B.SIMS GENERATING STATION	CH
	Juana's Packing Co., LLC-Main Plant	A
	Ken Zeinstra Farms	A
	LAKE WELDING SUPPLY COMPANY INC	A
	LAKESHORE FILTRATION PLANT	CH
	LEO DIETRICH & SONS	A
	MEAD JOHNSON AND COMPANY, LLC	CH
	MICHIGAN CELERY PROMOTION CO-O	A
	Midway Dairy	A
	MIEDEMA PRODUCE INC	A
	Neil Jacobsen Farm	A

Table 15, continued...

County	Company Name	Type of Exposure
OTTAWA	Neubecker Farms	A
	Polyply Composites LLC.	S
	QUINCY STREET, INC	A
	REQUEST FOODS	A
	Richard Bos Farm	A
	SARA LEE - ZEELAND	A
	SHERWIN - WILLIAMS COMPANY-HOLLAND	A
	SPECIALTY HEAT TREATING OF HOLLAND INC	A
	SUPERIOR SALES INC	A
	THE EDGE ICE ARENA	A
	TIARA YACHTS, INC.	S
	TOTAL LOGISTIC CONTROL, LLC	A
	UNIFORM COLOR COMPANY	M
	VERTELLUS SPECIALTIES - ZEELAND FACILITY	A
	Visser Dairy Farm - COOPERSVILLE & JENISON	A
	Zeeland Farm Services, Inc	A
SAGINAW	BRIDGEPORT WWTP	CH
	BUENA VISTA WWTP	CH
	Dow Corning Corporation - Healthcare Industries Materials Site	A
	FRANKENMUTH CITY OF WATER TREATMENT & WWTP	CH
	HI-TECH STEEL TREATING, INC.	A
	Nexteer Automotive	A
	SAGINAW CHARTER TOWNSHIP RETENTION BASIN & WWTP	CH
	Saginaw Stoker Drive	CH
	Thomson Aerospace & Defense	A
	WATER TREATMENT PLANT, SAGINAW & WWTP	CH
SANILAC	CROP PRODUCTION SERVICES - BROWN CITY, DECKERVILLE & SANDUSKY	A
	CROSWELL WATER PLANT	CH
	DGP INCORPORATED	S
SHIAWASSEE	Airgas Specialty Products - Owosso	A
	Bandkau Farms	A
	BENJAMIN, BEN FARM	A
	Brant Farms	A
	Crambell Farm	A
	Demerly Farm	A
	Durling Farms, LLC	A
	FROOM FARMS LLC	A

Table 15, continued...

County	Company Name	Type of Exposure
SHIAWASSEE	HARVEST MILLS	A
	Hull Farms	A
	KONDEL FARMS	A
	Luchenbill Farm	A
	MACHINE TOOL & GEAR, INC.	A
	Norder Farm	A
	Picnik Farms	A
	Spezia Farms	A
	UAP DISTRIBUTION	A
	V V Farms	A
	WAUSAUKEE COMPOSITES INC.	S
	Zdunic Farm	A
ST CLAIR	DUNN PAPER, INC.	CH
	LAKE HURON WATER TREATMENT PLANT	CH
	Marsyville Ethanol	A
	MARYSVILLE, CITY OF WWTP	CH
	Port Huron	CH
	Z F Marysville LLC	A
ST JOSEPH	Abbott Nutrition - Sturgis	A
	Aquatic Co.	S
	Mendon Unit 635	A
	MICHIGAN MILK PRODUCERS ASSOC	A
	STURGIS WASTEWATER TREATMENT PLANT	CH
	Three Rivers Wastewater Treatment Plant	CH
TUSCOLA	Agrium Advanced Technologies (U.S.), Inc.	A
	CARO WASTEWATER TREATMENT PLANT	CH
	CASS CITY WWTP	CH
	COOPERATIVE ELEVATOR CO	A
VAN BUREN	ALLOY STEEL TREATING CO INC	A
	City of South Haven,WWTP	CH
	Decatur	A
	FRUIT BELT CANNING COMPANY INC	A
	Grand Junction Facility	A
	HARTFORD WAREHOUSE	A
	LAWRENCE FREEZER CORP.	A
	Paw Paw River Produce	A
	Paw-Paw Plant	A
	RYDER PAW PAW LOGISTIC CENTER	A

Table 15, continued...

County	Company Name	Type of Exposure
VAN BUREN	SHAFER LAKE FRUIT, INC	A
	SILL FARMS MARKET, INC	A
	ST. JULIAN WINE COMPANY INC	A
	The Coca-Cola Company	A, CH
	WELCH FOODS, INC.	A
WASHTENAW	Ann Arbor	A, CH
	ANN ARBOR ICE CUBE	A
	Arctic Glacier Inc. Ypsilanti	A
	ASTRO CAP MANUFACTURING	S
	CHELSEA MILLING CO	CH
	CROP PRODUCTION SERVICES	A
	DAPCO INDUSTRIES	A
	ELECTRO ARC MFG. COMPANY	A
	PHOTO SYSTEMS, INC./BOTTCHER AMERICA INC.	F
	THETFORD CORPORATION - ANN ARBOR & DEXTER	F
WAYNE	3M DETROIT ABRASIVE	F
	A&R Packing Co Inc	A
	ARCTIC COLD STORAGE	A
	ARCTIC EDGE ICE ARENA	A
	ARTED CHROME PLATING INC	CH
	BASF CORPORATION	A, E, S
	Bld Canton	A
	BODYCOTE THERMAL PROCESSING	A
	BOTTLING GROUP LLC, PEPSI BOTT	A
	C. F. BURGER CO	A
	Canton - Detroit COC	CH
	CARDINAL HEALTH	F
	CHRYSLER-JEFFERSON NORTH ASSEMBLY PLANT	E, F
	CITY SPORTS CENTER	A
	CLASSIC PLATING	A
	COMPUWARE ARENA	A
	COUNTRY FRESH, LLC - LIVONIA	A
	CREST INDUSTRIES INC	S
	DAIRY FRESH FOODS INC	A
	dba Aldoa Company	E
	DEARBORN ICE SKATING CENTER	A
	DETROIT EDISON COMPANY-TRENTON CHANNEL PWR PLANT	A
	Detroit Production	A

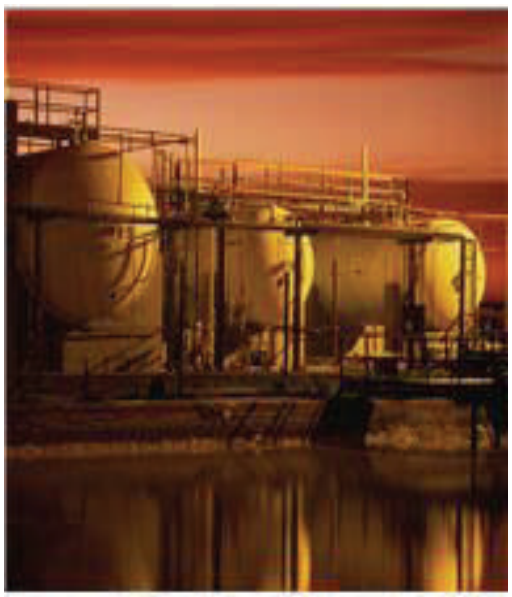
Table 15, continued...

County	Company Name	Type of Exposure
WAYNE	DETROIT WASTEWATER TREATMENT PLANT	CH
	Diversitak - Detroit & HIGHLAND PARK	E
	DURCON INC.	P
	Dynamic Surface Technologies International LLC	A
	EDDIE EDGAR ARENA	A
	FARMER'S COLD STORAGE, LLC.	A
	Faygo Beverages Inc.	A
	Freezer & Dry Storage LLC	A
	FREEZER SERVICES OF MI LLC	A
	FRITZ PRODUCTS	CH
	Gas Recovery Systems LLC - Arbor Hills	A
	GUTTER SUPPLIERS	F
	HOME CITY ICE COMPANY - Detroit	A
	Inland Waters Pollution Control, Inc.	S
	Interstate Chemical Company, Inc.	A, F
	JCI JONES CHEMICALS INC.	CH
	KENNEDY RECREATION CENTER	A
	LINCOLN DISTRIBUTING	S
	Mastronardi Produce	A
	MCLANE FOOD SERVICE - PLYMOUTH	A
	MELVINDALE CIVIC ARENA	A
	MICHIGAN DAIRY	A
	NORTHEAST WATER PLANT	CH
	POLYCHEMIE INC	F
	POLYMER CONCRETE CORPORATION	S
	PRAXAIR DISTRIBUTION INC	A
	PVS NOLWOOD CHEMICALS, INC.	F
	PVS TECHNOLOGIES, INC.	CH
	S & F FOODS	A
	Santemp	A
	SHERWOOD FOOD DIST	A
	SOUTH HURON VALLEY WWTP	CH
	SOUTHWEST WATER PLANT	CH
	SPRINGWELLS WATER TREATMENT PLANT	CH
	SYSCO DETROIT, LLC	A
	TRENTON, CITY OF WASTEWATER TREATMENT PLANT	CH
	UNISTRUT-WAYNE MANUFACTURING	A

Table 15, continued...

County	Company Name	Type of Exposure
WAYNE	WATER WORKS PARK PLANT	CH
	WHITE TOWER INDUSTRIAL LAUNDRY	CH
	WOLVERINE PACKING COMPANY DIST PLT & LAMB & VEAL PLANT	A
	WOODWORTH INCORPORATED	A
	WYANDOTTE Power Plant	CH
	Yack Arena	A
WEXFORD	AAR MOBILITY SYSTEMS	F
	Cadillac	CH
	CADILLAC PLANT	S
	Cruiser Division	S
	HARING TOWNSHIP WATER SUPPLY	CH
	Sport Division	S

[a]Source: Michigan Department of Environmental Quality (DEQ). Michigan Facilities' Guide to SARA Title III, Emergency Planning and Release Reporting, December 2007, 6th edition. The chemicals listed in this table are subject to reporting under the Emergency Planning and Community Right-to-Know Act (EPCRA) section 313, which is triggered by threshold amounts of 25,000 pounds manufactured or processed or 10,000 pounds otherwise used at facilities in Michigan. The companies listed in this table were current as of calendar year 2012 from a report generated by the Michigan DEQ on January 13, 2014.



Discussion

The consensus in the medical literature is that the true number of WRA cases is much greater than what is actually reported in public health surveillance systems, including Michigan's. The American Thoracic Society (ATS) released a consensus statement in 2003 that estimates in 15% of adults with asthma, the asthma is caused by work exposures.[6] In 2011, a second ATS consensus statement estimated 21.5% of adults with asthma have work-aggravated asthma.[7] The combined estimates from these consensus statements would indicate that 36.5% of all adult asthma is work-related.

For the years 2008-2010, 52.5% (95% CI 48.2-56.8%) of Michigan adults who were ever employed and currently have asthma reported that a health care provider told them or they told a health provider their asthma was caused or made worse by exposures at work (Source: Michigan Department of Community Health (MDCH). Michigan Asthma Call Back Survey, 2008-2010). Table 16 shows how this percentage varied by age, gender, race, annual income and education. Among those individuals who responded their asthma was caused or made worse by work, only 22% had a discussion about work's effect on their asthma with their health care provider.[1] At minimum, the data suggest that providers are not addressing concerns of their patients and probably missing the identification of WRA triggers.

National data showed that individuals with work-related asthma had higher mean numbers of days with asthma symptoms. Individuals with more days of symptoms were more likely to not be able to work or perform usual activities.[8]

On average, 141 new people each year have been reported to the Michigan Department of Licensing and Regulatory Affairs (LARA) with confirmed WRA. In recent years, the number of reports has decreased. One hundred three reports were confirmed in 2010, the most recent year with complete data. The number of individuals with exposure to a known occupational sensitizer (disease category OA) appears to show a downward trend, although there was a slight increase in 2004 that persisted in 2005 (Table 1). The reason for this trend is unknown and may be related to changes in reporting sources or to the success of workplaces in better controlling their employees' exposures to known sensitizers.

Based on responses from the 2005 BRFSS random sample of Michigan residents, we estimate that up to 62,000 (95% CI 42,000—83,000) Michigan adults have their asthma caused or aggravated by work.[1] Based on the medical literature we would estimate that there are 97,500 Michigan adults with WRA.[6] Using capture-recapture analysis, we estimate 228—801 adults in Michigan develop WRA each year.[9]

Workers are generally young to middle-age Caucasian men and women, with the greatest number being reported from the Detroit metropolitan area. However, the rate of WRA in African Americans is 1.5 times greater than among Caucasians. Based on an analysis conducted for previous annual reports, factors from the WRA surveillance data that would contribute to greater morbidity among African Americans include: a greater likelihood to continue to be exposed to the workplace agent, having a longer time of exposure before leaving work, and being less likely to receive workers' compensation.

As companies trim costs, especially in light of reduced production schedules, more temporary workers are being hired to do work on an as-needed basis. The transient nature of temporary work underscores the potential for under-counting of cases of WRA when employees move from job to job, especially those jobs that have a high potential for exposure to sensitizing agents.

Individuals in the Michigan work force tend to develop their asthma from exposure to agents in the manufacturing sector, particularly automobiles, machinery, metals, chemicals, and rubber and plastics. The predominant causes of WRA are isocyanates (13%), cleaning products (12%) and metal working fluids (10%). Until recently, metal working fluids were the second most frequently reported exposure at work.

The trend of fewer individuals with the known causes of WRA such as diisocyanates, metal-working fluids and high molecular weight compounds would suggest

improvements in controls when these agents are used since the number of facilities using isocyanates has increased. The lack of change in cases secondary to office and manufacturing exposures, and the increase in WRA secondary to cleaning agents suggests that exposures in these situations have proven more difficult to control (Figure 3).

We updated the table first presented in the 2002 Work-Related Asthma Annual Report (Table 14) on the number of manufacturing workers in companies that use isocyanates. In Midland, slightly more than 5% of the work force is employed in facilities where isocyanates are used. Health care providers can use this information to heighten their awareness of potential exposures to isocyanates among their patients with asthma.

Table 15 shows selected agents by county and company that have been associated with WRA. Health care providers can use this table as an initial step in evaluating possible exposure for their patients if they work at one of the facilities listed.

Asthma symptoms persist despite removal from the precipitating work exposures (Table 9). Studies show that the sooner an individual is removed from the exposure after symptoms develop, the more likely the individual's symptoms will resolve.[10] On the average, among the 2,064 individuals who are no longer exposed to the causal agent, almost three years elapse from onset of respiratory symptoms at work to date last exposed. We do not have data on how much of this delay is secondary to the individual not seeking medical care and how much is related to the physician not recommending that the individual leave the exposure.

Data from the United Kingdom estimated that when medical care and lost time are factored in, the work-related asthma costs were 100 million dollars per year with 49% of the cost borne by the patient, 48% by the State and only 3% by the employer.[11] We do not have cost estimates for Michigan, but given the fact that only 49% of individuals applied for Workers' Compensation benefits and we do not have universal health insurance as in the United Kingdom, we suspect that the individual patients in Michigan bear a high percentage of the costs associated with work-related asthma.

TABLE 16

Proportion of Asthma Attributable to Work Among Michigan Adults Who Were Ever Employed and Who Currently Have Asthma, Michigan Asthma Call Back Survey, 2008-2010 Combined

AGE in years	Proportion, %	95% Confidence Interval
18-34	39.9	29.6-51.1
35-64	61.8	57.5-65.9
>=65	43.8	38.3-49.5
GENDER		
Male	54.7	46.3-62.8
Female	51.4	46.5-56.2
RACE		
White	50.5	45.7-55.2
Black	58.9	46.7-70.1
ANNUAL INCOME		
<$20,000	60.6	51.1-69.3
$20,000-$34,999	60.3	50.6-69.1
$35,000-$49,999	51.4	41.2-61.5
$50,000-$74,999	54.7	42.2-66.7
>=$75,000	44.8	37.8-52.0
EDUCATION		
< High School	62.6	46.7-76.3
High School Graduate	57.4	49.1-65.3
Some College	51.1	43.4-58.7
College Graduate	48.7	41.7-55.8

Personal habits like cigarette smoking and individual susceptibility measured through personal or family history of allergies do not predict who develops WRA. About 50% of the WRA patients identified through the Michigan Tracking System have no personal or family history of allergies and 80% are not smoking cigarettes at the time their asthma symptoms develop (Tables 6-8).

Although most facilities where the patient developed asthma were in compliance with exposure standards, there were high percentages of symptomatic co-workers identified in those facilities. It is possible that either air sampling was not conducted under similar enough conditions as the exposures associated with the development of the index cases' asthma, such as spills or leaks, or that the current standards are not protective enough.

We identified 1,565 fellow workers with symptoms compatible with WRA (Table 13). Five hundred seventy-eight individuals were listed on the MIOSHA Injury and Illness Log (Form 300) as having WRA or symptoms compatible with WRA. There was only an overlap of nine individuals of co-workers reporting symptoms on co-worker interviews and those being reported on the MIOSHA Log. Part of the reason for the lack of overlap is that half of the symptomatic individuals indicate they have never seen a doctor for their respiratory symptoms.

Medical monitoring is particularly relevant to reducing the burden of work-related causes of asthma. The longer a person with asthma remains exposed, the more likely their asthma will become a chronic problem.[10] A review of companies using isocyanates showed that only 32% were providing periodic medical surveillance.[12]

The percentages of individuals reported with work-related asthma that this surveillance system documented with breathing tests performed in relation to work was less than 10%. This reflects the standard of medical care in the United States where the diagnosis of WRA is made from the patient's history. More frequent use of objective pulmonary function testing performed in relation to work would allow health care providers to feel more confident about advising their patients to leave their work exposure.

Cessation of exposure is the most important aspect of treatment; patients who are removed from exposure the soonest have the best prognosis.[10] Effective asthma treatment requires that the health care providers consider a patient's asthma triggers. Many times the health care provider reacts to concerns that their patient raises about workplace exposures, rather than proactively inquiring whether their patient has triggers at work that contribute to their respiratory symptoms. One of the factors related to a 2005 death caused by isocyanate exposure was that the primary care physician waited until the patient requested a medical restriction, rather than instructing the patient at an earlier time that he needed to be removed from any further exposure to isocyanates at work.

The report of a patient with known or suspected WRA is a sentinel health event that is critical to effective occupational disease surveillance. Case reporting from physicians offers the opportunity for the most timely workplace interventions, compared to receiving reports from hospitals. With continued support and increasing awareness of WRA by physicians and other health professionals, we can continue to provide timely intervention in the workplace, offer suggestions for reducing workplace exposures even if they are below the current permissible exposure limits, document the need for the development of new standards, identify new occupational allergens, and prevent co-workers from developing disease.

The potential that 54% of Michigan adults with asthma report that work causes or aggravates their work-related asthma must be integrated into all asthma initiatives planned on surveillance and education, both for health care providers and the public.

References

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APPENDIX

2012 PATIENT NARRATIVES BY TYPE OF INDUSTRY & EXPOSURE

Abbreviations:

OA = Occupational Asthma with Exposure to a Known Sensitizer

POA = Possible Occupational Asthma, Work-related Symptoms, but Exposure is not a Known Sensitizer

AA = Aggravated Asthma (Pre-Existing Asthma Exacerbated at Work)

RADS = Reactive Airways Dysfunction Syndrome

The patient narratives that follow are based on information collected from interviews of patients about their health and work status.

MANUFACTURING

EXPOSURE TO ISOCYANATES

OA3269. A female developed asthma in her 30s from exposure to isocyanates. She had worked for almost five years at an automotive interior manufacturing plant before she was given a new job as a tucker. About six months after starting this new job within the plant, she developed wheezing, cough and shortness of breath. At first, her symptoms resolved on weekends or during the plant shut down. However, about two months after her symptoms began, they became worse and she was prescribed Albuterol, ProAir, Advair and Singulair. She continues to work in the same job, and her asthma symptoms and medication use have remained the same. She was unable to tolerate wearing a respirator. She smoked a pack of cigarettes a day, since her early teens.

OA3213. A male in his 20s developed work-related asthma from exposure to toluene diisocyanate (TDI) one month after starting work at an automotive seat manufacturer. He developed wheezing, cough and chest tightness and was prescribed Prednisone, Albuterol and Advair. He continued to work at the company despite ongoing exposure. His asthma did improve and he required less asthma medication. He had never smoked cigarettes.

OA3414. A male developed asthma in his 50s after working at a foundry for 10 years. He was exposed to isocyanates in his job as a foreman, troubleshooting problems and supervising the flow of work in the Molding Department. He developed wheezing, a cough and shortness of breath and was prescribed Albuterol, Advair and Prednisone. Shortly after his diagnosis, the company went out of business. Over a year and a half later, since being out of work, his asthma had improved and he required less asthma medication. He smoked two cigarettes a day for less than a year in his teens.

OA3419. A female developed asthma in her 50s from exposure to methylene diisocyanate (MDI), an ingredient in a glue, and saw dust. She had a production job at an automotive parts manufacturer. She developed wheezing and shortness of breath and was prescribed Qvar, Singulair and Albuterol. She went on medical disability for her worsening asthma. She was a pack a day cigarette smoker, since her mid-teens.

OA3256. A male developed asthma in his 40s from exposure to toluene diisocyanate (TDI) at an automotive seat manufacturer. He had only worked for about one month before his asthma developed. His job was to place metal frames into seat molds; this job was about 10 feet away from the TDI foaming operation. He developed cough, wheezing, shortness of breath and chest tightness. He was treated at an Emergency Department five times, and prescribed Prednisone, ProAir and Flovent. He continued to work at the company for about six months until he was placed on workers' compensation. One month after being out of the exposure to TDI, his asthma symptoms improved and his asthma medication use was less. He smoked five cigarettes a day for eight years, but quit in his mid 30s.

AA3254. A male auto manufacturer worker in his 50s experienced an aggravation of his pre-existing asthma from exposure to isocyanates used as foam filler for parts shipments. The foam bags protected the auto parts and held them in place during shipping. The off-gases from the foam as it cured in the bags aggravated his asthma.

Exposure to Metal Working Fluids

OA3263. A female developed asthma in her 40s two months after beginning to work at a company that made aluminum valves. She was exposed to coolants used during grinding of the valves. She experienced wheezing, cough, shortness of breath and chest tightness and was prescribed Albuterol. She continued to work at that job for almost three more years, until she finally quit because of her lung problems. After leaving that job, her asthma symptoms improved and she required less asthma medication. She smoked a half a pack of cigarettes a day since her late teens.

AA3316. A male in his 40s experienced an exacerbation of his pre-existing asthma when he was moved to a new location of a large automotive parts manufacturing plant. He was a die setter and his asthma flared up from exposure to coolants. About a month after his asthma flared up, he was put on disability leave. He had smoked an average of three packs a day of cigarettes for 30 years, but quit when his asthma flared up at work.

RADS3257. A female developed RADS in her 40s from an acute exposure to a spill of metal working fluids in her job as an assembly line worker at an automotive parts manufacturing company. After the spill. she immediately developed cough, wheezing, chest tightness and shortness of breath, and was taken to a local Emergency Department where she was treated with Albuterol. She was fired from her job. Since that time, her breathing problems have improved and required less asthma medication. She smoked a pack of cigarettes a day from her 20s to her mid 50s.

Exposure to Fiberglass

POA3335. A male developed asthma in his 20s while working at a fiberglass manufacturer. He worked at the facility for over five years before he developed a cough, chest tightness and shortness of breath; he was seen at the Emergency Department and subsequently hospitalized for his breathing difficulties. He was prescribed Albuterol. Since the initial asthma attack, he was reassigned to a new job. He has not experienced any breathing difficulties at his new job assignment and was able to discontinue his asthma medication. He smoked a pack of cigarettes a day for about five years, but quit smoking about one year prior to the development of his asthma.

AA3269. A female in her 40s experienced an exacerbation of her pre-existing asthma in her job at an automotive headliner manufacturer. She was exposed to fiberglass falling down on her when she pulled tape off the headliner. She continued to do this job and required more asthma medication. She smoked about a half a pack of cigarettes a day since her mid-teens.

Exposure to Welding Fume

OA3314. A male in his 30s developed WRA from exposure to welding fume. He was employed through a temporary employment agency as a welder at an auto rack manufacturer for almost a year before he developed wheezing, cough, chest tightness and shortness of breath. He was prescribed asthma medication but did not fill the prescription because he did not have health insurance. He was fired approximately three months after starting to work at the company, because of lost work time for his breathing difficulties. In the three months he had worked at the company, he had been to the Emergency Department four times. Since leaving the job, his symptoms have resolved. He has smoked one pack of cigarettes a day, for almost 20 years. He never had asthma before beginning the welding job. He had not found new employment at the time of interview.

AA3248. A female in her 40s experienced an exacerbation of her pre-existing asthma from exposure to welding fume from the work station next to hers. She worked at an automotive assembly plant. She had been moved to a new

work station near the welders about a week prior to the incident. She was treated at the company medical department and returned to an assembly job.

Exposure to Flour

OA3230. A male developed asthma in his 20s from working as a baker. He was exposed to flour. He developed wheezing when he started this job, and was prescribed Albuterol. He continued to work at the production bakery for seven years, after which he found a job in the trucking industry. His asthma improved and he required less asthma medication after leaving the bakery. He was a life-long non-smoker.

Exposure to Cleaning Products

AA3258. A male in his 20s experienced an exacerbation of his childhood asthma at a tortilla chip manufacturer when a co-worker accidentally mixed cleaning agents used to sanitize the equipment. The asthma attack from this exposure sent him to the Emergency Department for treatment. After the incident, he was reassigned to a new job not involving sanitation of the machines. However, his asthma worsened with more frequent asthma attacks, and he required more asthma medication since the incident. He had never smoked cigarettes.

RADS3240. A female developed RADS in her 20s after she was exposed to some cleaners that were accidentally mixed together. She had been working for about six months at an auto manufacturer, as a CNC bender operator, making metal tubes for trucks. The cleaning chemicals were accidentally mixed in the bathroom at the plant. When she walked into the bathroom, there was a large cloud in the air from the chemicals, and she immediately experienced cough, wheezing, shortness of breath and chest tightness. She was taken to the Emergency Department and prescribed Maxair, Qvar, Spiriva and Combivent. Since the accidental exposure, her symptoms improved and she required less asthma medication. She was a lifelong non-smoker.

Exposure to Miscellaneous Chemicals and dusts

OA3218. A male developed asthma in his 20s while working as a coffee roaster. He had done this job for two years before he developed shortness of breath. Two years later, he developed wheezing and a cough, and was prescribed Qvar, Advair, Asmanex and a rescue inhaler. Two years after his diagnosis, he reported that he continued to do this job. He continued to have asthma symptoms and required the same amount of asthma medication. He was a life-long non-smoker.

POA3272. A female developed asthma in her 50s after working at a printing company for five years. Her job was to spray glue to the bindings of books, and also to spray glue on special orders such as Christmas cards. She developed wheezing and shortness of breath and was prescribed Prednisone, Symbicort, Qvar, Ventolin and a nebulizer. Since her diagnosis, the company discontinued taking orders requiring the glue, and she wore a respirator since she was still exposed to paper dust. Since the glue was discontinued, her asthma improved and she required less asthma medication. She smoked a pack of cigarettes a day since her mid-20s.

POA3288. A female developed asthma in her 50s after working for about five months at an automotive stamping plant. Her job was to place stickers on the stamped parts before they were shipped out. She developed shortness of breath when exposed to fumes from the heated stickers. About a month after her asthma developed, she was placed on disability leave. Since that time, her asthma improved and she required less asthma medication. She was a life-long non-smoker.

POA3279. A female developed asthma in her 50s, approximately six months after beginning to work at an auto parts manufacturing facility. The company made wooden steering wheels for high-end vehicles. Her job was to sand the wood, and also to sand down the clear-coat on the steering wheels after it was applied. She developed wheezing, cough and shortness of breath and was prescribed Spiriva, Albuterol, Advair, Combivent and a steroid. She continued to work almost 10 years in that job, until her asthma worsened. She was then reassigned to a new job and location in the plant, and her asthma improved, although she required more asthma medication. She was a life-long non-smoker.

POA3244. A male wine cellar worker developed asthma in his 50s, after working at a wine cellar for five years. His job was to run a machine that bottled the wine. He was exposed to a chemical called Velcorin, which is a preservative and sterilizing agent used in the wine making industry. He was prescribed Combivent and Symbicort for his asthma. He continued to work at the wine cellar, but ended up leaving the job about six months after his diagnosis. Over a year later

he had not found another job. Since his diagnosis, his asthma has gotten worse. He smoked a pack of cigarettes a day for over 30 years, but quit when he developed asthma.

POA3251. A female vehicle inspector developed asthma in her 50s, after working for over 25 years at an auto manufacturer. She was exposed to gasoline exhaust and fumes at the end of the assembly line. She developed chest tightness and shortness of breath and was prescribed Symbicort and Spiriva. She continued to work in that area for almost a year, until she was placed on disability for an unrelated injury. Since being on disability, her asthma symptoms improved and she required less asthma medication. She smoked a pack of cigarettes a day for over five years in her late teens till her early twenties.

POA3212. A male millwright developed asthma in his 50s from exposure to rust inhibitor at an automotive assembly plant. He worked for about seven years before he developed wheezing, chest tightness and shortness of breath. He was prescribed Spiriva, Advair and ProAir. He continued to work in this environment for another seven years before he went on disability for an unrelated issue. Since being off work, his asthma remained unchanged although he required less asthma medication. He smoked a pack of cigarettes a day for over 45 years, but quit a few years after he developed asthma. A pulmonary function test showed a mild obstructive lung defect.

POA3222. A female developed asthma in her 40s after working for three years at a company that made advertising graphics and displays. She was exposed to paint fume, acetone and ink fume. She developed wheezing, a cough, chest tightness and shortness of breath and was prescribed Flovent, Zyrtec, ProAir and Nasonex. One year after her diagnosis, she continued to work at the company. She reported her asthma had worsened and she was also given Prednisone for her symptoms. She was a life-long non-smoker.

POA3357. A male materials mixer developed work-related asthma in his 20s after working for two years at an automotive manufacturing plant. He compounded chemicals used to make auto parts. He developed wheezing, cough, chest tightness and shortness of breath and was prescribed asthma medication. He made several trips to the Emergency Department. His employer would only allow him to wear a dust mask, and over the course of two years since the onset of symptoms, his breathing became worse. He quit that job to avoid the exposure causing his asthma. Since leaving the job, his symptoms decreased and he required less asthma medication. He was a life-long non-smoker.

AA3301. A male hi-lo repairman in his 60s experienced an exacerbation of his pre-existing asthma from exposure to leaking battery acid at an automotive assembly plant. He worked at the plant for almost 20 years before the leaking chemicals triggered an asthma attack. He was transferred to another location in the plant and since then had not experienced any asthma attacks and did not require asthma medication. He was a life-long non-smoker.

AA3268. A male in his 60s experienced an exacerbation of his pre-existing asthma while working in inventory control at an automotive transmission manufacturer. The plant was undergoing construction work, and it was during this time that he developed wheezing, chest tightness and shortness of breath on the job. The construction work lasted about eight months. Once it was completed, his asthma symptoms improved. He smoked a pack of cigarettes a day from his early-teens to his 50s.

AA3255. A female in her 30s experienced an exacerbation of her pre-existing asthma while working at an automotive parts manufacturer. She was not sure what triggered the asthma attack at work, but smelled chemical odors in the Door Line station. She was treated at the company medical department and was able to return to work afterwards.

AA3315. A male in his 50s experienced an exacerbation of his pre-existing asthma at his job at an automotive assembly plant. His job was on the assembly line. Construction work was being done near the area where he worked, which triggered an asthma attack.

AA3428. A female in her 40s experienced an exacerbation of her pre-existing asthma after working for two years at a plastic injection molding company. She reported an exacerbation of her symptoms from the mold release spray, used to keep the plastic parts from sticking to the mold. About a month after the asthma attack from exposure to the mold release spray, she found a new job, upon the advice of her doctor. Since she left the job, her asthma improved and she required less asthma medication. She was a lifelong non-smoker.

AA3338. A female in her 40s experienced an exacerbation of her pre-existing asthma at her job in an automotive parts manufacturing facility. She had respiratory symptoms triggered by an acute exposure to the powder residue from the

resin used in the plastic injection mold machine that she operated. Since that incident, the company instituted safety measures to prevent the resin powder from being blown into her work area. She was a life-long non-smoker.

AA3311. A male in his 30s experienced an exacerbation of his pre-existing asthma from exposure to acid fumes at an automotive metal coating plant. He was treated at an Emergency Department and prescribed Albuterol and Prednisone. He was a life-long non-smoker.

AA3270. A female in her 50s experienced an exacerbation of her pre-existing asthma from exposure to dusts and mold in her office at an automotive manufacturing facility. She was a lifelong non-smoker. Since working off-site, she did not experience any more asthma attacks.

AA3324. A female in her 30s experienced an exacerbation of her pre-existing asthma at her job at an auto manufacturing plant. She described dust and poor ventilation in the Materials Department, and it was this area of the plant that would trigger her asthma attacks. She left work on disability, and since that time her asthma has improved.

AA3293. A female in her 40s experienced an exacerbation of her preexisting asthma. She was an assembler at an automotive assembly plant. She described the work environment as dusty. She continued to work at the plant in the same job. She occasionally had asthma flare ups at work, and sought treatment at the company medical department.

RADS3250. A male maintenance worker developed RADS in his 40s from exposure to smoke from a fire at an automotive plant. Within 24 hours of helping to put out the fire, he developed wheezing, cough and shortness of breath. He was prescribed a steroid, a rescue inhaler and Xolair. Since the fire, he continued to require asthma medication for his breathing difficulties. He was a life-long non-smoker.

EDUCATIONAL SERVICES

Exposure to Indoor Air Contaminants

POA3312. A female developed asthma in her thirties, two years after starting work as a high school teacher. She was exposed to dusts and fumes from a heater. The room where she taught had no windows and no cross ventilation. She continued to work in the classroom for almost 20 years, until she went on disability leave for her asthma. Since being out of the school environment, her asthma symptoms improved, although she still required asthma medication. She was a life-long non-smoker.

AA3241. A female in her 60s experienced an exacerbation of her pre-existing asthma when construction work was being done near her office in the building where she worked as a case manager for job training of disabled persons. She worked in the building for almost 30 years before the construction work was done. She was reassigned to a new area and since that time her asthma improved, although she required more asthma medication. She was a life-long non-smoker.

Exposure to Animal Dander

OA3217. A female graduate assistant developed asthma in her 20s after working for about six months at a university, working with mice. She sought medical treatment for her wheezing and cough and was prescribed Advair and ProAir. She continued to work with the mice; her symptoms and medication use remained unchanged. She was a life-long non-smoker.

Exposure to Miscellaneous Chemicals and dusts

RADS3271. A male community assistant in his 40s developed RADS after putting out a fire in the school cafeteria. Within 24 hours he experienced wheezing, chest tightness and shortness of breath and was prescribed an Albuterol inhaler by the school system's physician. Since the fire, he has been on medical leave, and his asthma and medication use has remained unchanged. He was a life-long non-smoker.

HEALTH CARE SERVICES

Exposure to Cleaning Products

POA3308. A female developed asthma in her 30s after working for one year as a nurse at a hospital. She was exposed to floor stripper and floor wax. She continued to work at the hospital for 25 years, and only had asthma symptoms

when the floors were stripped and waxed. Over time, her asthma worsened. She took Albuterol as needed. She was a life-long non-smoker.

POA3348. A female developed asthma in her 40s after starting to work at a hospital as a medical office assistant. When she was first exposed to cleaning substances used on the floors, she immediately experienced wheezing, chest tightness, a cough and shortness of breath. She was prescribed Singulair, Advair and Albuterol. She continued to work at the hospital in this job for 15 years since her diagnosis. Her breathing problems were worse and she required more asthma medication. Since the initial exposure, she had four visits to the Emergency Department and was hospitalized four times. She was a life-long non-smoker.

AA3368. A nursing assistant in her 50s experienced an exacerbation of her pre-existing asthma from exposure to floor stripper. She was treated at an Emergency Department for the asthma attack from this exposure. After this event, the nursing home where she worked arranged so the stripper would no longer be used in the building. She had never smoked cigarettes. About a year after this incident, she was fired.

AA3377. A female in her 20s experienced an exacerbation of her pre-existing asthma from exposure to an accidental mixing of cleaning agents. She had been working as a caregiver at a nursing home for about a year before the incident where she mixed a toilet bowl cleaner with household bleach. Since the incident, she did not have any other asthma attacks at work, and did not mix cleaning agents together. She smoked a half a pack of cigarettes a day since her mid-teens.

AA3415. A female in her 50s experienced an exacerbation of her pre-existing asthma at the hospital where she worked as a patient sitter in the rehabilitation center. The floors were being stripped and waxed, and a lacquer spray was applied to the wood floors. Exposure to these chemicals triggered an asthma attack. This was not her usual work area; she did not have exposure to these chemicals since the incident. Her asthma remained unchanged and she required the same amount of asthma medication as she previously used. She was a life-long non-smoker.

Exposure to Latex

OA3280. A female nurse's aide in her 50s developed asthma from exposure to latex. She developed asthma about three years after beginning to work at a nursing home. She was initially prescribed Ventolin and Spiriva, and then later additionally prescribed Symbicort. She smoked four cigarettes a day for over 35 years.

Exposure to Indoor Air Contaminants and Miscellaneous Chemicals and dusts

AA3299. A female dietary aide in her 20s experienced an exacerbation of her pre-existing asthma at a retirement home. Her asthma was triggered by drywall dust from construction. She left this job shortly after the incident and worked at a different retirement home while attending college. She did not have any further asthma attacks since starting her new job. She was a life-long non-smoker.

AA3287. A female housekeeper in her 50s experienced an exacerbation of her pre-existing asthma from exposure to paint fumes. She worked at a doctor's office, which was being painted. The paint triggered an asthma attack. She had worked at this location for over 10 years before this incident. She was treated at an Emergency Department. After the painting was finished, she was able to return to work.

AA3322. A female in her 40s experienced an exacerbation of her pre-existing asthma from exposure to chemicals and dust from roofing repairs being done at the hospital where she worked. She was exposed to the chemicals and dust for a two week period during which the repairs were being made. During this time, she was treated at the Emergency Department and prescribed Albuterol and steroids. Since the roof repairs were completed, she did not have another asthma attack and she required less asthma medication. She was a life-long non-smoker.

WHOLESALE & RETAIL SERVICES

Exposure to Cleaning Products

AA3253. A female cashier in her 70s experienced an exacerbation of her pre-existing asthma at a grocery store when a janitor accidently spilled a bucket of bleach near another cleaning agent. The mixture of the two cleaning agents triggered her asthma attack, for which she was ultimately hospitalized. Since the exposure, she was too ill to work. She worked at the store for almost 10 years prior to this incident. Since being off work, her asthma improved although she still

required the same amount of asthma medication. She was a life-long non-smoker.

Exposure to Miscellaneous Chemicals and dusts

OA3358. A female meat wrapper developed breathing problems in her 30s from exposure to heated plastic when wrapping meat at a grocery store. She had worked in this job for approximately one year before her symptoms began. Within one year of starting this job, she developed wheezing. After two years on the job she developed a cough, chest tightness, and shortness of breath. She continued to work as a meat wrapped for over 15 years before being diagnosed with asthma and being prescribed Albuterol, Combivent, Advair and Steroids. At that point, she was also put on oxygen and could not return to her job. Six months after leaving her job, her asthma remained the same, and she required a greater amount of asthma medication. She smoked a pack of cigarettes a day from her mid 20s till she was diagnosed with asthma.

AA3261. A female in her 50s experienced an exacerbation of her pre-existing asthma while working through a temporary staffing agency for a fruit and vegetable distributor. Her job was to package the produce for shipment. She was not sure what triggered her asthma attack on the job, but described the work environment as cold and damp. She worked 12-hour shifts. She left this job shortly after starting to work there, because she could not tolerate the working conditions. She was not able to find a new job. Since leaving this job, her asthma improved and she did not require asthma medication. She smoked a pack-a-day of cigarettes for 30 years until she quit in her mid-40s.

OFFICE

Exposure to Indoor Air Contaminants

POA3220. A female developed asthma in her 30s as soon as she began working as a loan officer at a bank. She described the office environment as damp and moldy. She continued to work at the office for another six months before she was taken to the Emergency Department for an asthma attack, and prescribed Ventolin. She stopped working at that time. Since then, her asthma improved and she required less asthma medication. She smoked a half a pack of cigarettes a day since her early 20s. She had not returned to work at the time of interview, six months after her ED visit.

POA3283. A female developed asthma in her 20s, less than a year after starting to work in an insurance office. She was exposed to dust. She was prescribed Albuterol and a steroid. She left the job several months after her asthma developed. Six months later, there was no change in her asthma or medication use. She was a life-long non-smoker.

POA3361. A female developed asthma in her 40s about two years after starting to work in an office as a customer service representative for a communications company. When renovations were being made to the office area, she developed wheezing, cough, chest tightness and shortness of breath. She required multiple visits to the Emergency Department and was hospitalized several times for her breathing difficulties. She was prescribed Albuterol, Prednisone, Singulair and ProAir. She was moved to a different work area away from the remodeling activities. Her asthma remained unchanged and she required more asthma medication. She was a life-long non-smoker. Pulmonary function testing showed a moderate obstructive lung defect and she had a significant response to bronchodilator.

AA3339. A female supervisor in her 50s experienced an exacerbation of her pre-existing asthma at her government office job. She described exposure to mold in the building where she worked, possibly in the ceiling tiles. She continued to work at the same location; her asthma worsened and she required a greater amount of asthma medication. She smoked half a pack of cigarettes a day, for about five years from her mid-teens to her early twenties.

AGRICULTURE

Exposure to Cleaning Products

AA3289. A male in his 30s experienced an exacerbation of his pre-existing asthma when he was exposed to cleaning agents used to disinfect milk jars at a dairy farm. His job was to transport the milk from dairy farms. At one farm, he opened a jar containing an acid and soap mixture, and experienced an asthma attack. He went to the Emergency Department of a local hospital for treatment. After this incident, his asthma symptoms returned to the level they were prior to the exposure, and his asthma medication use was reduced. He continued to do this job, as a self-employed contractor. He was a life-long non-smoker.

MISCELLANEOUS SERVICES & INDUSTRIES

EXPOSURE TO FLOUR

OA3232. A female developed asthma in her 40s from exposure to flour at the bakery where she worked. She mainly helped to decorate cakes, but would also help with loading flour into the mixer in a small room at the bakery. She worked for six years before she developed a cough and shortness of breath. She was prescribed Ventolin and Advair. She went on disability leave and since that time her asthma improved and she required less asthma medication. She smoked a half a pack of cigarettes a day for over 10 years from her mid-teens to her late twenties.

EXPOSURE TO CLEANING PRODUCTS

AA3310. A female in her 20s experienced an exacerbation of her asthma while working as a janitor for a building cleaning service. Her asthma attack was set off by cleaning with bleach. She was treated at an Emergency Department with Advair and Albuterol. She never smoked cigarettes.

AA3349. A female in her 20s experienced an exacerbation of her pre-existing asthma while working at a fast food restaurant. Exposure to grease smoke and cleaning products caused her childhood asthma to flare up. She was fired about two years after working at the restaurant, from missing work due to doctor visits. She found other employment, her asthma symptoms improved and she required less asthma medication. She never smoked cigarettes.

RADS3268. A male in his 40s developed RADS from an acute exposure to muriatic acid, which he was spraying to clean the concrete surface of a building. He developed a cough and was treated and prescribed Asmanex and a Medrol dose pack. He smoked a pack a day of cigarettes since his early 20s.

RADS3267. A female in her 50s developed RADS from an acute exposure when cleaning chemicals were accidentally mixed while cleaning toilets. She worked for a cleaning company. Within 24 hours of being exposed to bleach, ammonia and Pine Sol, she experienced a cough and shortness of breath. She was treated at an Emergency Department and prescribed Albuterol and steroids. She smoked about four cigarettes a day.

RADS3306. A self-employed house cleaner developed RADS in her 40s when she accidentally mixed Clorox bleach and Pine Sol. She immediately developed a cough and chest tightness and was prescribed an inhaler during an Emergency Department visit. She continued to clean houses. Since the acute exposure, her breathing symptoms became worse and she required more asthma medication. She was a life-long non-smoker.

EXPOSURE TO MISCELLANEOUS CHEMICALS AND DUSTS

AA3313. A female in her 20s worked at a hotel as a receptionist. She was exposed to chlorine from the swimming pool which was down the hall from the hotel's front desk. After working at this job for about two years, she experienced an exacerbation of her childhood asthma. She reported that her asthma was aggravated at work, especially after busy weekends when the pool was used a lot and more chlorine was used. She eventually found a new job and since that time did not have any asthma episodes. She was a lifelong non-smoker.

AA3424. A female in her late teens with pre-existing asthma worked at the pool at a country club. She experienced an aggravation of her asthma several hours after a co-worker accidentally poured chlorine into a hydrochloric acid mixture in the pool area. She was treated at a local Emergency Department for an asthma attack. She was discharged after the asthma treatments she received at the hospital ED controlled her asthma.

AA3229. After working for over 10 years, a female in her 30s experienced an aggravation of her asthma at her job at a post office. Her asthma attack was triggered by being around people wearing perfume. She was treated at an Emergency Department and prescribed additional medications, Clarinex, Flovent and Atrovent. She continued to work at the post office with more respiratory symptoms, which required more asthma medication. She was a life-long non-smoker.

AA3403. A male in his 40s experienced an exacerbation of his pre-existing asthma while conducting a home visit as a theft inspector for a power company. He walked into a home and was overcome by fumes from several kerosene heaters and a heated room fragrance. He sought treatment at a local Emergency Department. Since that incident, he did not have any further asthma episodes and required less asthma medication. He was a life-long non-smoker.

JUSTICE, PUBLIC ORDER, & SAFETY

Exposure to Latex

OA3371. A female prison supervisor developed asthma in her 30s from exposure to latex gloves. She worked at the sheriff's department for six years, wearing latex gloves with no allergic symptoms. She began to experience a cough and shortness of breath and was positive to latex on allergy testing. She was prescribed Prednisone and Albuterol. The sheriff's office substituted non-latex gloves and since that time her asthma improved and she no longer required daily asthma medication. She was a life-long non-smoker.

Exposure to Miscellaneous Chemicals and dusts

RADS3282. An office worker at a police station developed RADS in her 60s when an insecticide was sprayed due to a scabies outbreak, and cleaning agents were used following the insecticide application in a closed room. She immediately experienced a cough and was prescribed Advair, Singulair and Ventolin at the Emergency Department. Approximately one year later she retired, after over 20 years on the job. Since that time her respiratory symptoms improved although she still required the same amount of asthma medication. She smoked four cigarettes a day for less than a year in her teens.

CONSTRUCTION

Exposure to Isocyanates

OA3300. A male developed asthma in his 30s after working for 10 years at a company that installed residential insulation. His job was to install insulation in homes; the year the company began to use a 2-part spray of a resin and isocyanate, he developed a cough, shortness of breath, chest tightness and wheezing. He did not seek treatment for his symptoms until two years later when he was prescribed an inhaler by a pulmonologist. He now had to wear an air-supplied respirator in order to continue to do the installation work. Since his diagnosis, his asthma worsened and he required a greater amount of asthma medication. He smoked two packs of cigarettes a day since his early teens.

Exposure to Miscellaneous Chemicals and dusts

POA3404. A female developed asthma in her 40s while working for a construction company. She was exposed to an unknown chemical for two days. She developed wheezing, cough and shortness of breath, was treated at an Emergency Department and prescribed Albuterol, Prednisone and Solu-medrol. She smoked one pack a day of cigarettes.

TRANSPORTATION

Exposure to Cleaning Products

RADS3266. A male in his 30s developed RADS as a contract employee for the State of Michigan Department of Transportation. His job was to clean the bathrooms at rest areas. He was exposed to cleaning chemicals that were accidentally mixed together while trying to unclog a toilet. Within 24 hours, he developed a cough and chest tightness. He went to an Emergency Department and was prescribed an Albuterol inhaler and steroids. He smoked a half a pack of cigarettes a day, for 15 years.

Exposure to Miscellaneous Chemicals and dusts

AA3346. A female customer service representative in her 40s experienced an exacerbation of her pre-existing asthma at an airline company. She was exposed to fumes from cars when assigned to the garage area at the airport. It was only in this location where she had symptoms. She continued to work at the airport, her asthma worsened, and she required a greater amount of asthma medication. She was a life-long non-smoker.

RADS3294. A male in his 50s developed RADS from exposure to fire extinguisher chemicals when the extinguisher exploded in his cab. He worked as a car hauler for a transportation company. The fire extinguisher exposure happened only once; he immediately experienced chest tightness and shortness of breath. He was prescribed ProAir, Advair and Singulair at an Emergency Department. He occasionally but not regularly smoked cigarettes.