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To protect, promote & improve the health
of all people in Florida through integrated
state, county & community efforts.



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Governor

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Vision: To be the Healthiest State in the Nation

Sulfuryl Fluoride Exposure Calls to the Florida Poison Information Center Network, 2010-2015

December 11, 2015

Introduction

Sulfuryl fluoride is a commonly used fumigant in structural (building) fumigations. Four commercial formulations containing sulfuryl fluoride are currently registered in Florida: Vikane[®], Profume[®], Zythor, and Master Fume[®]. It is a colorless, odorless, non-flammable gas that is used to eliminate dry-wood termites, insect pests, and rodents. Chloropicrin is added to the sulfuryl fluoride gas fumigant as a “warning agent” that encourages people to vacate an area before being exposed to a lethal dose of the gas fumigant. The U.S. Environmental Protection Agency (EPA) has classified sulfuryl fluoride as a restricted use pesticide (RUP) that should only be used by certified pesticide applicators. The area to be fumigated is usually covered with a tarp or tent and sealed completely before releasing the gas. Pesticide applicators post warning signs around the building notifying people to keep out. After fumigating for set period of time (ranging from 2 to 72 hours), the tarp is removed and the structure is aerated using fans. Pesticide applicators are required to measure the level of sulfuryl fluoride remaining in the living space to ensure it is below the EPA approved concentration before allowing occupants to reentry. Structures can be occupied only when the concentration is one part per million or less.

Acute pesticide-related illness and injury (poisoning) is a reportable condition under section 381.0031, Florida Statutes and Florida Administrative Code Chapter 64D-3. All physicians, laboratories, and other health care providers are required to report acute pesticide poisonings to the Florida Department of Health (DOH). DOH received 17 reports of pesticide-related illness and injury cases with exposure to sulfuryl fluoride from January 1, 2010 through October 31, 2015. To better understand the burden of sulfuryl fluoride poisonings in Florida, a review of Florida Poison Information Center Network (FPICN) data was completed.

Methods

All exposure calls to FPICN were assessed, managed, and coded by specialists in poison information (SPIs) who are pharmacists, nurses, physicians, or physician assistants trained and certified to operate the FPICN hotline. Sulfuryl fluoride exposure calls to FPICN were extracted from the statewide database for January 1, 2010 through October 31, 2015. Calls coded as “unrelated effect,” and “confirmed as a non-exposure” were excluded from the analysis. These calls were determined not to be true sulfuryl fluoride exposures based on information received during the call and the technical experience of the SPI. Information obtained from FPICN exposure records included age, gender, county where the call originated, date of call, site of exposure, exposure reason, site where exposure was managed, exposure substances, signs or symptoms, and medical outcome. Exposure information is primarily based on reports from the provider or self-reported by an exposed individual, a friend, or a family member. Signs and symptoms were categorized into gastrointestinal (GI), neurological, cardiovascular, respiratory, and ocular syndromes based on the American Association of Poison Control Centers (AAPCC) categories by organ system.

Results

From January 1, 2010 to October 31, 2015, 166 calls were received by FPICN related to sulfuryl fluoride exposure (average of 28 calls per year). Table 1 displays characteristics of sulfuryl fluoride exposures reported to FPICN. Ages of exposed individuals ranged from <1 year old to 84 years old (average age of 30 years). Women were exposed slightly more often compared to men. Most calls occurred during the third quarter (July, August, and September) of 2013, 2014, and 2015 (Figure 1).

Among 166 calls received by FPICN, sulfuryl fluoride exposure was the only substance involved in most (93.4%) exposure calls. Most exposures were unintentional (94.6%), occurred at a residence (86.1%), and were managed at the call site (56%). The largest number of exposures were reported in Miami-Dade (30.7%), Broward (17.5%), Palm Beach (12%), Pinellas (9%), and Hillsborough (7.8%) counties.

Of the 166 exposures, 89 (53.6%) were not followed by the SPI for reasons including inability to contact the patient for follow-up, exposure judged to result in minimal effects with follow-up not needed, or patient refused follow-up and exposure was judged likely to result in minimal effects. Sixty eight (41.0%) of these 89 individuals had unknown symptoms. An additional 30 (18.1%) did not have signs or symptoms. Signs and symptoms were collected for the remaining 68 (41.0%) exposed individuals (Table 1). Common clinical syndromes among 68 individuals who reported signs and symptoms were GI (57.4%), neurological (47.1%), respiratory (33.8%), and ocular (33.8%). Common symptoms reported were nausea (19.1%), eye irritation or pain (19.1%), dyspnea (17.6%), headache (16.2%), vomiting (14.7%), and dizziness (14.7%). Minor illness occurred in 35 individuals (51.5%) and moderate illness occurred in 10 individuals (14.7%). Major illness was reported in a 9-year-old boy following house fumigation in Martin County. The boy presented to an emergency department with nausea, vomiting, muscle twitching, and decreased mentation. The boy was treated in the hospital for about two weeks and then sent to a rehabilitation hospital. The SPI attributed illness to sulfuryl fluoride exposure. One death was reported in a 30 year old woman who prematurely entered a home in Manatee County that was being tent fumigated with Vikane®. She developed dyspnea and agitation and was transferred to a local hospital. Later that day she died from cardiac arrest in the hospital. The SPI attributed death to sulfuryl fluoride exposure.

Characteristics of exposures differed by age (Table 2). Most of the exposures occurred in adults aged 25-49 years. Unintentional exposures were common among all age groups. Children <5 years old most often had no symptoms reported. Moderate illness was often reported among those ≥25 years old. Adults were typically en route to a health care facility when FPICN was called or referred to a health care facility by the SPI. Exposures in children <5 years of age were commonly managed at the call site. GI and neurological signs and symptoms were the most common among adults with age 25-49 years.

Discussion

Sulfuryl fluoride poisoning usually occurs after inhalational exposure. Review of FPICN data identified 166 calls related to sulfuryl fluoride exposure. The predominant manifestations of sulfuryl fluoride poisoning are respiratory irritation and neurologic symptoms. People who have intentionally entered fumigated structures and have been exposed for more than 30 minutes to high concentrations of the gas fumigant have developed fluid in their lungs, which causes coughing, vomiting, restlessness, muscle twitching, and eventually, convulsions. Breathing can stop from the effects on the nervous system. A relatively limited number of studies on acute and chronic sulfuryl fluoride exposures have reported neurotoxic effects to the peripheral and central nervous system in animals and humans. There are very few epidemiologic studies that have examined sulfuryl fluoride exposures in humans. Fatalities have been reported from acute sulfuryl fluoride poisoning¹⁻⁴. Similarly, in FPICN call data, exposed individuals have commonly reported GI symptoms followed by neurological and respiratory symptoms.

Chloropicrin is a “mucous membrane irritant”, also known as a tear gas. It is a clear, colorless, non-flammable gas with a strong, sharp, irritating odor. It is added to the sulfuryl fluoride gas fumigant as a “warning agent”. Signs and symptoms depend on the amount of exposure time. Chloropicrin can cause eye, nose, throat, and upper respiratory irritation. In FPICN call data, only 8 individuals were listed as exposed to both sulfuryl fluoride and chloropicrin.

Individuals who call FPICN for sulfuryl fluoride exposure were most likely to have unintentional inhalational exposure that results in minimal or no symptoms. Among 68 individuals who reported symptoms, only 17.6% reported more than a minor illness. FPICN managed most of the individuals (56.0%) at the call site (see Table 1). This shows that FPICN often receive calls related to low-level sulfuryl fluoride exposures that result in minimal symptoms or those not requiring treatment by a health care provider.

Education related to the effects of sulfuryl fluoride should target homeowners, especially during the summer months, and should focus on safety precautions and preparation for home fumigations. Homeowners and occupants need to talk to a professional pesticide applicator, understand the process, and follow instructions for personal safety. Occupants need to cover or remove items and clear the building until permitted by the applicator for reentry. Homeowners may wish to further ventilate the house by opening doors and windows.

This review of FPICN data is subject to at least two limitations. First, FPICN is not always notified of all sulfuryl fluoride exposures or poisonings by patients, witnesses to the event, and health care providers. Second, these call data are highly reliant on the knowledge, attitudes, and practices of residents around the use of FPICN services. Self-reported sulfuryl fluoride exposure calls to FPICN may not be considered a confirmed exposure by all, due to non-availability of exposure evidence.

If people become sick after pesticide exposure, they should:

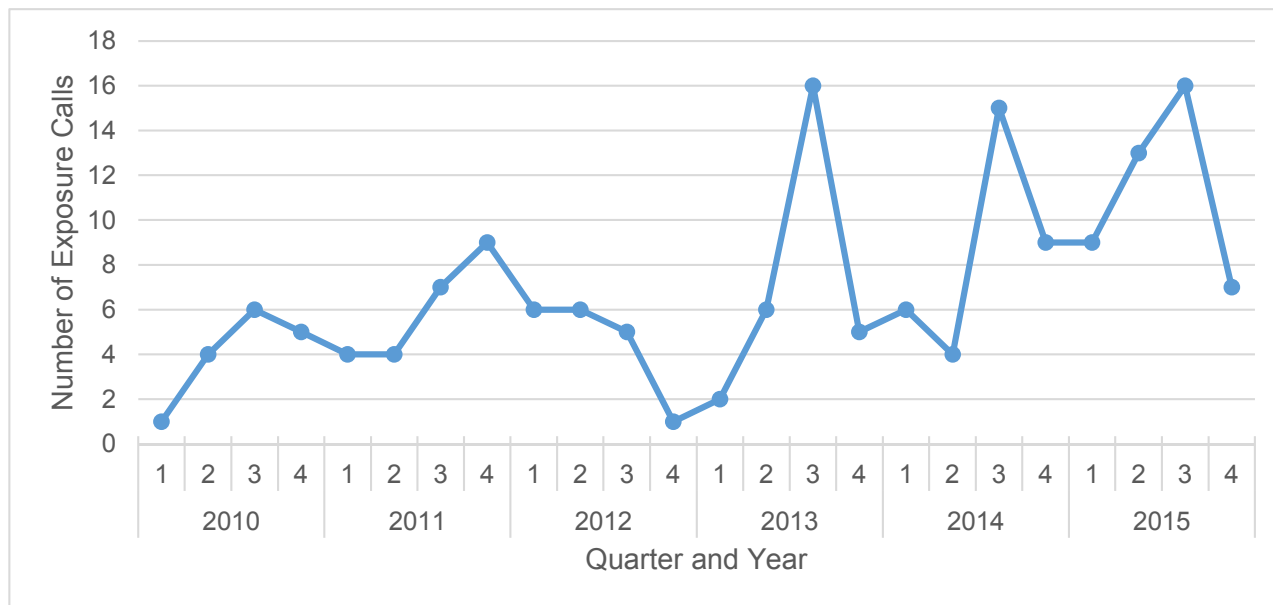
1. Seek medical attention from a physician or emergency department.
2. Call FPICN at 1-800-222-1222. Trained staff can provide specific poison information and treatment recommendations related to the exposure.
3. Report health effects due to pesticide exposure to the Florida Department of Health (DOH) local county health department (contact information available here: <http://www.Floridahealth.gov/CHDEpiContact>) or the DOH pesticide surveillance hotline at 1-800-606-5810.

DOH has developed a training for physicians and nurses titled “Recognition, Management, and Reporting of Acute Pesticide Poisonings in Florida” to increase identification of pesticide poisonings and reporting to DOH. This training has been approved for 1.5 CME/CE credits and is available at: <https://stellared.learningexpressce.com/index.cfm?fa=view&eventID=4190>.

References

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2. Calvert GM, Mueller CA, Fajen JM, et al. Health Effects Associated With Sulfuryl Fluoride and Methyl Bromide Exposure Among Structural Fumigation Workers. *Am J Public Health* 1998;88:1774-80.
3. CDC. Fatalities Resulting From Sulfuryl Fluoride Exposure After Home Fumigation--Virginia. *MMWR* 1987;36:602-4, 609-11.
4. Scheuerman EH. Suicide by Exposure to Sulfuryl Fluoride. *J Forensic Sci* 1986;31:1154-8.

Figure1: Sulfuryl Fluoride Exposure Calls to the Florida Poison Information Center Network by Quarters* Per Year (N=166), January 1, 2010 to October 31, 2015.



* Quarter 1: January, February and March; Quarter 2: April, May and June; Quarter 3: July, August and September; Quarter 4: October, November and December

Table 1: Characteristics of Sulfuryl Fluoride Exposures Reported to the Florida Poison Information Center Network (N=166), January 1, 2010 to October 31, 2015.

Characteristic	Number	Percent
Age groups (years)		
<5	19	11.4
05-24	35	21.1
25-49	57	34.3
≥50	27	16.3
Unknown	28	16.9
Gender		
Female	81	48.8
Male	74	44.6
Unknown	11	6.6
Substance category		
Fumigants	155	93.4
Fumigants; Lachrymators	8	4.8
Fumigants; Asthma therapies	1	0.6
Fumigants; Alcohols	1	0.6
Fumigants; Antacids	1	0.6
Exposure reason		
Unintentional	157	94.6
Intentional	9	5.4

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Exposure site		
Residence	143	86.1
School	8	4.8
Vehicles	3	1.8
Workplace	12	7.2
Management site		
Referred to health care (HC) facility	16	9.6
En route to HC facility	47	28.3
Managed on site	93	56.0
Other (non-physician HC provider)	10	6.0
Signs and symptoms		
Yes	68	41.0
No	30	18.1
Unknown	68	41.0
Medical outcome		
Death	1	0.6
Major illness	1	0.6
Moderate illness	10	6.0
Minor illness	35	21.1
Not followed	80	48.1
Unable to follow	9	5.4
No symptoms	30	18.1
Clinical syndrome (68 individuals with signs and symptoms could report >1 syndrome; percentages do not add to 100%)		
Gastrointestinal	39	57.4
Neurological	32	47.1
Respiratory	23	33.8
Ocular	23	33.8
Cardiovascular	6	8.8
Dermal	3	4.4
Miscellaneous	23	33.8
County		
Miami-Dade	51	30.7
Broward	29	17.5
Palm Beach	20	12.0
Pinellas	15	9.0
Hillsborough	13	7.8
Manatee	5	3.0
Orange	5	3.0
Volusia	5	3.0
Other	22	13.3
Unknown	1	0.6

Table 2: Characteristics of Sulfuryl Fluoride Exposures Reported to the Florida Poison Information Center Network by Age Group (N=138)*, January 1, 2010 to October 31, 2015.

Characteristic	<5 years		5-24 years		25-49 years		≥ 50 years	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Gender								
Female	10	52.6	11	31.4	31	54.4	18	66.7
Male	9	47.4	23	65.7	25	43.9	8	29.6
Unknown	0	0.0	1	2.9	1	1.8	1	3.7
Exposure reason								
Unintentional	19	100.0	32	91.4	54	94.7	26	96.3
Intentional	0	0.0	3	8.6	3	5.3	1	3.7
Management site								
Referred to health care (HC) facility	0	0.0	4	11.4	7	12.3	4	14.8
En route to HC facility	3	15.8	10	28.6	19	33.3	7	25.9
Managed on site	16	84.2	20	57.1	28	49.1	15	55.6
Other (non-physician HC provider)	0	0.0	1	2.9	3	5.3	1	3.7
Medical outcome								
Death	0	0.0	0	0	1	1.8	0	0
Major illness	0	0.0	1	2.9	0	0	0	0
Moderate illness	0	0.0	0	0	5	8.8	3	11.1
Minor illness	1	5.3	9	25.7	17	29.8	4	14.8
Not followed	12	63.2	16	45.7	24	42.1	13	48.1
Unable to follow	0	0.0	1	2.9	4	7	3	11.1
No symptoms	6	31.6	8	22.9	6	10.5	4	14.8
Clinical syndrome (68 individuals with signs and symptoms could report >1 syndrome; percentages do not add to 100%)								
Gastrointestinal	0	0.0	7	13.2	22	22.4	8	19
Neurological	0	0.0	6	11.3	21	21.4	3	7.1
Respiratory	1	5.0	3	5.7	7	7.1	10	23.8
Ocular	1	5.0	7	13.2	10	10.2	4	9.5
Cardiovascular	0	0.0	1	1.9	2	2	3	7.1
Dermal	0	0.0	0	0	2	2	0	0
Miscellaneous	1	5.0	5	9.4	11	11.2	2	4.8
No or unknown symptoms	17	85.0	24	45.3	23	23.5	12	28.6

*Age is unknown for 28 individuals from FPICN data