Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 61 / No. 48
December 7, 2012

Chlorine Gas Release Associated with Employee Language Barrier — Arkansas, 2011

On June 27, 2011, a worker at a poultry processing plant in Arkansas began to pour sodium hypochlorite into a 55-gallon drum that contained residual acidic antimicrobial solution. When the sodium hypochlorite reacted with the solution, greenish-yellow chlorine gas was released into the small room where the drum was located and then spread into the plant, where approximately 600 workers were present. These workers promptly were evacuated. Chlorine is a respiratory irritant and can produce symptoms ranging from mild eye, nose, and throat irritation to severe inflammation of the lung, which can lead to death (*1*). Of the approximately 600 workers who were evacuated; 545 were later interviewed, 195 reported seeking medical treatment, 152 reported being hospitalized, and the plant nurse reported that five were admitted to intensive-care units. The next day, the Occupational Safety and Health Administration (OSHA) asked for technical assistance from CDC's National Institute for Occupational Safety and Health (NIOSH) to evaluate health effects of the release and make recommendations to prevent future occurrences. This report describes the results of that evaluation, including findings from two follow-up site visits conducted approximately 4 and 6 months after the release. Of the 545 workers who participated in the evaluation, three developed reactive airways dysfunction syndrome (RADS), an irritant-induced form of asthma that can persist for life. The worker who inadvertently mixed the two solutions indicated that the drum was labeled in English but he could only read Spanish. This incident underscores the danger posed by chlorine gas and the importance of employers providing adequate training and communication of health and safety precautions to employees.

On their first visit to the plant, conducted June 30–July 2, 2011, NIOSH investigators interviewed 523 workers who were at work during the chlorine release. They later interviewed 22 workers who had been off work after the chlorine release when the first visit was made. The ages of the participants ranged from 18 to 72 years, with an average of 42 years; 326 (60%) of the participants were women (Table 1). The participants were interviewed in their primary languages. A total of 371 (68%) participants, including the worker who was filling the drum with sodium hypochlorite, spoke Spanish as their primary language; 91 (17%) primarily spoke English; 68 (12%) primarily spoke Marshallese; and 15 (3%) primarily spoke other languages. Investigators learned that the acidic antimicrobial solution was normally stored in much larger, square containers, but one sample drum inadvertently had been left in the plant in the area where the sodium hypochlorite normally was located, and was labeled only in English. The worker who mixed the sodium hypochlorite with the leftover acidic solution told investigators he knew such a mixture was dangerous but did not recognize the drum and could not read the label to ascertain its contents. When interviewed, the worker was unable to respond in English and required a Spanish translator.

During the first plant visit, participants were asked about their asthma history, smoking status, the strength of the chlorine odor they experienced (used as a surrogate for intensity of exposure), and any symptoms in the first 24 hours after the release and at the time of interview (i.e., 3–5 days after the release). During the second visit in November, a survey that included four questions adapted from the European Community Respiratory Health Survey (ECRHS) (*2*)* was administered to workers who had reported lower respiratory

* Additional information available at http://ac.els-cdn.com/S0895435602006133/1-s2.0-S0895435602006133-main.pdf?_tid=d3e8123a-3d5d-11e2-a775-00000aacb35d&acdnat=1354548577_565682c901907f1a04879273f9d4edaf.

Continuing Education examination available at http://www.cdc.gov/mmwr/cme/conted_info.html#weekly.

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

tract symptoms (i.e., cough, wheezing, chest tightness, or shortness of breath) during the first visit and to the 22 workers who were absent at the first site visit.[†]

A positive response to any of the four questions on the survey has a sensitivity of 75% and a specificity of 80% for asthma symptoms on the basis of a clinical examination with immunoglobulin E testing against common allergens, spirometry, and methacholine challenge testing (MCT).[§] These questions had been modified by substituting "since the chlorine release," for "in the last 12 months." Participants were classified as having presumptive RADS[¶] if they answered "yes" to any of the ECRHS questions and did not have asthma before the chlorine release. During the third plant visit, conducted in January 2012, investigators performed spirometry on 101 participants who had been classified as having presumptive RADS at the second visit; they also conducted MCT on 78 of those, based on spirometry results (forced expiratory volume in 1 second of ≥70%) and the presence or absence of medical contraindications to MCT. Participants were defined as having RADS if they had no history of asthma before the release, presumptive RADS at the second visit, and a positive MCT result. Participants were defined as having borderline RADS if they had no history of asthma, one or more RADS symptoms at the second visit, and a borderline-positive MCT result.

Of 543 participants providing information on smoking status, 411 (76%) had never smoked, 73 (13%) were former smokers, and 59 (11%) were current smokers. Thirty-four participants (6%) reported a history of asthma (Table 1).

A total of 520 participants provided information regarding the strength of the chlorine odor during the release; 213 (41%) reported a strong odor, 36 (7%) reported a moderate odor, 117 (23%) reported a light odor, and 154 (30%) said they did not smell chlorine. Among those reporting a strong odor, the most common symptoms in the first 24 hours after release were burning throat (175 [82%]), headache (173 [81%]), burning eyes (157 [74%]), and cough (154 [72%]) (Table 2). Among those reporting a strong odor, the most common symptoms 3–5 days after release were headache (148 [69%]), burning

[†] The questions were 1) Have you been woken up with a feeling of tightness in your chest at any time in the last 12 months? 2) Have you had an attack of asthma in the last 12 months? 3) Are you currently taking any medicine (including inhalers or pumps, aerosols, or tablets) for breathing problems or asthma? and 4) Have you had wheezing or whistling in your chest at any time in the last 12 months?

[§] MCT is performed to assist in the diagnosis of RADS. After baseline spirometry is obtained, methacholine (a bronchoconstricting agent) is inspired through a nebulizer at a series of up to 5 increasing doses. The dose that results in a 20% fall in the forced expiratory volume at 1 second is called the PC20. If the PC20 is <4 mg/mL, bronchial hyperreactivity is occurring (positive test result); if PC20 is 4–16 mg/mL, borderline bronchial hyperreactivity is occurring; and if the PC20 is >16 mg/mL, the test result is considered normal.

[¶] The diagnostic criteria for RADS are 1) a documented absence of preceding respiratory complaints; 2) the onset of symptoms occurred after a single specific exposure incident; 3) the exposure was to a gas, smoke, fume or vapor that was present in very high concentrations and had irritant qualities to its nature; 4) the onset of symptoms occurred within 24 hours after the exposure and persisted for at least 3 months; 5) symptoms simulated asthma with cough, wheeze, and dyspnea predominating; 6) pulmonary function tests might show airflow obstruction; and 7) MCT testing result was positive; 8) other types of pulmonary diseases were ruled out. Source: Brooks SM, Weiss MA, Bernstein IL. Reactive airways dysfunction syndrome (RADS). Persistent asthma syndrome after high level irritant exposures. Chest 1985; 88:376–84.

The *MMWR* series of publications is published by the Office of Surveillance, Epidemiology, and Laboratory Services, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30333.

Suggested citation: Centers for Disease Control and Prevention. [Article title]. MMWR 2012;61:[inclusive page numbers].

TABLE 1. Number and percentage of poultry plant workers present during a chlorine gas release who were interviewed,* by selected characteristics — Arkansas, 2011

Characteristic	No.	(%)
Sex		
Women	326	(60)
Men	219	(40)
Primary language		
Spanish	371	(68)
English	91	(17)
Marshallese	68	(12)
Other	15	(3)
Smoking status		
Never	411	(76)
Former	73	(13)
Current	59	(11)
History of asthma		
Yes	34	(6)
No	509	(94)

* N = 543–545. Denominators vary because of missing data.

TABLE 2. Prevalence of symptoms within 24 hours of chlorine gas release among poultry plant workers who reported strength of chlorine odor* — Arkansas, 2011

	Strength of chlorine odor							
	Strong		Moderate		Light		None	
Symptoms	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Total	**213**	**(41)**	**36**	**(7)**	**117**	**(23)**	**154**	**(30)**
Mucus membrane								
Burning eyes	157	(74)	18	(50)	36	(31)	15	(10)
Burning nose	124	(58)	12	(33)	25	(21)	7	(5)
Burning throat	175	(82)	20	(56)	39	(33)	17	(11)
Constitutional								
Dizziness/ Lightheadedness	135	(63)	16	(44)	27	(23)	9	(6)
Headache	173	(81)	22	(61)	50	(43)	23	(15)
Chest								
Chest congestion or phlegm	105	(49)	11	(31)	10	(9)	9	(6)
Chest pain	140	(66)	12	(33)	23	(20)	7	(5)
Chest tightness	119	(56)	13	(36)	10	(9)	10	(6)
Cough	154	(72)	21	(58)	38	(32)	12	(8)
Coughing up blood	21	(10)	0	(0)	1	(1)	0	(0)
Shortness of breath	142	(67)	14	(39)	14	(12)	6	(4)
Wheezing in chest	86	(40)	4	(11)	7	(6)	3	(2)
Gastrointestinal								
Nausea	111	(52)	13	(36)	15	(13)	7	(5)
Vomiting	53	(25)	5	(14)	7	(6)	3	(2)
Skin								
Irritation/Pain/Burning	56	(26)	3	(8)	6	(5)	4	(3)

* N = 520.

throat (140 [66%]), cough (136 [64%]), and shortness of breath (118 [55%]) (Table 3).

Of the 545 participants, 267 (49%) either reported lower respiratory tract symptoms 3–5 days after the release or had not returned to work at the time of the first site visit. At the second site visit, 240 (90%) of these 267 participants were surveyed, and 105 (44%) had presumptive RADS. At the third site visit, 101 (96%) of the 105 participants with presumptive RADS were available for further testing; of these, 23 had medical conditions incompatible with MCT, had uninterpretable spirometry results, or did not meet spirometry criteria for MCT. MCT was conducted on 78 (77%) of the 101. Of the 78 tested, three had borderline RADS, and three had RADS.

TABLE 3. Prevalence of symptoms 3–5 days after chlorine gas release among poultry plant workers who reported strength of chlorine odor* — Arkansas, 2011

	Strength of chlorine odor							
	Strong		Moderate		Light		None	
Symptoms	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Total	**213**	**(41)**	**36**	**(7)**	**117**	**(23)**	**154**	**(30)**
Mucus membrane								
Burning eyes	103	(48)	11	(31)	25	(21)	8	(5)
Burning nose	70	(33)	7	(19)	20	(17)	6	(4)
Burning throat	140	(66)	14	(39)	34	(29)	14	(9)
Constitutional								
Dizziness/ Lightheadedness	100	(47)	8	(22)	16	(14)	7	(5)
Headache	148	(69)	15	(42)	38	(32)	23	(15)
Chest								
Chest congestion or phlegm	92	(43)	9	(25)	16	(14)	12	(8)
Chest pain	113	(53)	7	(19)	22	(19)	8	(5)
Chest tightness	98	(46)	11	(31)	12	(10)	8	(5)
Cough	136	(64)	16	(44)	27	(23)	12	(8)
Coughing up blood	18	(8)	0	(0)	0	(0)	1	(1)
Shortness of breath	118	(55)	9	(25)	19	(16)	8	(5)
Wheezing in chest	59	(28)	4	(11)	5	(4)	5	(3)
Gastrointestinal								
Nausea	72	(34)	6	(17)	10	(9)	5	(3)
Skin								
Irritation/Pain/Burning	42	(20)	2	(6)	8	(7)	6	(4)

* N = 520.

Reported by

Ashley Whitlow, MS, Shirley Louie, Arkansas Dept of Health. Charles Mueller, MS, Bradley King, MPH, Elena Page, MD, Bruce Bernard, MD, Div of Surveillance, Hazard Evaluations, and Field Studies, National Institute for Occupational Safety and Health; Francisco Meza, MD, EIS Officer, CDC. ***Corresponding contributor:*** *Elena Page, epage@cdc.gov, 513-458-7144.*

Editorial Note

This chlorine release and its resultant health effects were preventable. OSHA issued the owner of the poultry plant a citation for not ensuring that chemical hazard communication training was understood by all employees. The OSHA Hazard Communication Standard states, "Employers shall provide employees with effective information and training on hazardous chemicals in their work area at the time of their initial

assignment, and whenever a new physical or health hazard the employees have not previously been trained about is introduced into their work area."** Under the standard, employers also are expected to communicate work instructions and information on workplace hazards to employees tailored to the employees' language and education level (*3*). The growing presence of Spanish-speaking workers in the United States, and the high rates of morbidity and fatalities among Hispanic workers, point to the need for improved workplace instruction and training to ensure employee comprehension (*4*).

The worker who began to pour sodium hypochlorite into the drum that had contained an acidic antimicrobial solution did not recognize the drum, had limited English skills, and was unable to read the label on the drum that had been inadvertently left in the wrong place. As a result of its investigation, NIOSH recommended 1) providing material safety data sheets and labeling in the languages spoken at the facility, 2) ensuring that employee training programs regarding hazardous chemicals used on-site and needed protective measures comply with upcoming changes in the OSHA Hazard Communication Standard, 3) installing special fittings to prevent inadvertent connections between the filling station and containers, 4) keeping incompatible chemicals in different sized or different colored barrels to prevent them from being mixed together, and 5) establishing evacuation plans and drills appropriate for potential hazards at the facility.

At the poultry plant, Spanish was the primary language for 68% of the workers, and Marshallese was the primary language for 12%. These percentages are higher than those for the racial/ethnic composition of workers in the U.S. animal slaughtering and processing industry cited by the Bureau of Labor Statistics, which indicated that 38.1% of workers were Hispanic or Latino and 8.6% were Asian in 2011 (*5*). The potential for injury as a result of inadequate attention to foreign language health and safety training extends beyond this industry, with approximately 40.4 million foreign-born residents in the United States, 46.6% of whom are Hispanic and 51.0% who report an inability to speak English very well (*6*).

In addition, an estimated 30 million adults with below basic literacy skills often are working in dangerous jobs (*4,7*). Nonetheless, most material safety data sheets used in industry are written at a college reading level, making communication with most workers difficult; the problem is compounded when workers do not speak English well or at all (*8*).

** Additional information available at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10099.

What is already known on this topic?

Chlorine is a respiratory irritant and can produce symptoms ranging from mild eye, nose, and throat irritation to severe inflammation of the lung. Despite current standards regarding hazard communication, including those related to inadvertent release of chlorine gas, workplaces might not have adequate hazard communication programs.

What is added by this report?

A large release of chlorine gas in a poultry processing plant exposed approximately 600 workers and resulted in 152 workers being hospitalized, five in an intensive-care unit; three went on to develop reactive airways dysfunction syndrome. Investigators found that the chlorine was released because a Spanish-speaking worker could not read the English-language label on a container containing acid that was left in the wrong place.

What are the implications for public health practice?

This case demonstrates the urgency of implementing hazard communication programs and training in workplaces in the United States. All communication, training, and signage in the workplace should be easy-to-read and provided in languages understood by workers.

To help overcome language and literacy obstacles, employers should actively engage workers in hands-on training (*9*). To lessen communication gaps, training should be interactive, and employees and employers should work together to analyze and improve workplace health and safety policies and programs. OSHA has made changes to its Hazard Communication Standard that will be phased in over the next 4 years, in accordance with recommendations from the United Nations (*10*). These changes establish a standardized international labeling system (Globally Harmonized System of Classification and Labeling of Chemicals) to be used by manufacturers of chemicals. Using symbols and simplified text, its intent is to improve understanding of chemical hazards for all employers and employees, regardless of primary language or literacy level.

Acknowledgments

Williamina Bing, Kenny Boaz, Arkansas Dept of Health. Candis Hunter, MSPH, Agency for Toxic Substances and Disease Registry. Melody Kawamoto, MD, Walter Alarcon, MD, Elizabeth Garza, MPH, Rachel Weintraub, Diana Freeland, Brian Tift, MS, David Spainhour, Michael Beaty, National Institute for Occupational Safety and Health, CDC.

References

1. Agency for Toxic Substances and Disease Registry. Toxicological profile for chlorine. Atlanta, GA: US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry; 2004.
2. Grassi M, Rezzani C, Biino G, Marinoni A. Asthma-like symptoms assessment through ECRHS screening questionnaire scoring. J Clin Epidemiol 2003;56:238–47.
3. Occupational Safety and Health Administration. OSHA training standards policy statement. Washington, DC: US Department of Labor, Occupational Safety and Health Administration; 2010. Available at http://www.osha.gov/dep/standards-policy-statement-memo-04-28-10.html. Accessed November 26, 2012.
4. Johnson S, Ostendorf J. Hispanic employee in the workplace: higher rate of fatalities. AAOH J 2010;58:11–6.
5. Bureau of Labor Statistics. Household data: annual averages. [Table 18] Employed persons by detailed industry, sex, race, and Hispanic or Latino ethnicity. Washington, DC: US Department of Labor, Bureau of Labor Statistics; 2011. Available at http://www.bls.gov/cps/cpsaat18.pdf. Accessed November 26, 2012.
6. US Census Bureau. American Community Survey. Selected characteristics of the native and foreign-born populations: 2011 American Community Survey 1-year estimates. Washington, DC: US Department of Commerce, Economics and Statistics Administration, US Census Bureau; 2010. Available at http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_1YR_S0501&prodType=table. Accessed November 27, 2012.
7. US Government Accountability Office. Safety in the meat and poultry industry, while improving, could be further strengthened. Washington DC: US Government Accountability Office; 2005. Available at http://www.gao.gov/products/gao-05-96. Accessed November 26, 2012.
8. Arcury TA, Estrada JM, Quandt SA. Overcoming language and literacy barriers in safety and health training of agricultural workers. J Agromedicine 2010;15:236–48.
9. Wallerstein N. Health and safety education for workers with low-literacy or limited-English skills. Am J Ind Med 1992;22:751.
10. Occupational Safety and Health Administration. Hazard communication. Washington, DC: US Department of Labor, Occupational Safety and Health Administration; 2012. Available at http://www.osha.gov/dsg/hazcom/index.html. Accessed November 26, 2012.