MMWR™
Morbidity and Mortality Weekly Report
Weekly April 27, 2007 / Vol. 56 / No. 16

Workers' Memorial Day — April 28, 2007

Workers' Memorial Day, April 28, was established to recognize workers who died or were injured on the job. On average, nearly 16 workers in the United States die each day from injuries sustained at work (*1*), and 134 die from work-related diseases (*2*). Daily, an estimated 11,500 private-sector workers have a nonfatal work-related injury or illness, and as a result, more than half require a job transfer, work restrictions, or time away from their jobs (*3*). Approximately 9,000 workers are treated in emergency departments each day because of occupational injuries, and approximately 200 of these workers are hospitalized (*4*). In 2004, workers' compensation costs for employers totaled $87 billion (*5*).

Workers' Memorial Day 2007 also will commemorate the thirty-sixth anniversary of the creation of the National Institute for Occupational Safety and Health in the U.S. Department of Health and Human Services and the Occupational Safety and Health Administration in the U.S. Department of Labor. Additional information on workplace safety and health is available online at http://www.cdc.gov/niosh/homepage.html or by telephone, 800-356-4674.

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Fixed Obstructive Lung Disease Among Workers in the Flavor-Manufacturing Industry — California, 2004–2007

Bronchiolitis obliterans, a rare and life-threatening form of fixed obstructive lung disease, is known to be caused by exposure to noxious gases in occupational settings and has been described in workers in the microwave-popcorn industry who were exposed to artificial butter-flavoring chemicals, including diacetyl (*1,2*). In August 2004, the California Department of Health Services (CDHS) and Division of Occupational Safety and Health (Cal/OSHA) received the first report of a bronchiolitis obliterans diagnosis in a flavor-manufacturing worker in California. In April 2006, a second report was received of a case in a flavor-manufacturing worker from another company. Neither worker was employed in the microwave-popcorn industry; both were workers in the flavor-manufacturing industry, which produces artificial butter flavoring and other flavors such as cherry, almond, praline, jalapeno, and orange. Both workers had handled pure diacetyl, an ingredient in artificial butter and other flavorings, and additional chemicals involved in the manufacturing process. Studies have indicated that exposure to diacetyl causes severe respiratory epithelial injury in animals (*3–5*). Because the manufacture of flavorings involves more than 2,000 chemicals, workers in the general flavor-manufacturing industry are

INSIDE

DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION

The *MMWR* series of publications is published by the Coordinating Center for Health Information and Service, 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 2007;56:[inclusive page numbers].

exposed to more chemicals than workers in the microwave-popcorn industry, which primarily uses butter flavorings. Food flavorings are designated "generally recognized as safe" when approved by the U.S. Food and Drug Administration (*6*); flavorings are not known to put consumers at risk for lung disease. This report describes the first two cases of bronchiolitis obliterans in flavor-manufacturing workers in California, the findings of the public health investigation, and the actions taken by state and federal agencies to prevent future cases of occupational bronchiolitis obliterans. To identify cases and reduce risk for lung disease from occupational exposure to flavorings, a timely, effective response is needed, including medical surveillance, exposure monitoring, and reduced exposure.

Case Reports

Case 1. In September 2003, a man aged 29 years with no history of smoking, lung disease, or respiratory symptoms developed progressive shortness of breath on exertion, decreased exercise tolerance, intermittent wheezing, left-sided chest pain, and a productive cough 2 years after beginning employment as a flavor compounder. His job involved measuring diacetyl and other ingredients to prepare batches of powder flavorings. The workplace did not have effective methods for controlling exposure to the flavoring chemicals, such as local exhaust ventilation or adequate use of respirators to reduce exposure to organic compounds and powders. The worker reported wearing a paper dust mask and occasionally a cartridge respirator for organic vapors. However, he never received a fit test for the respirator. He had a beard at the time, which precluded a proper fit, and he was not adequately protected from both volatile organic chemicals and particulates.

In November 2003, the man went to his primary-care physician and was treated with antibiotics and bronchodilators for suspected bronchitis and allergic rhinitis. In January 2004, he stopped working because of his respiratory symptoms. His shortness of breath became more severe, with dyspnea after walking 10–15 feet. A high-resolution computed tomography (HRCT) scan of his chest showed cylindrical bronchiectasis in the lower lobes, with scattered peribronchial ground-glass opacities. In April 2004, spirometry showed severe obstructive lung disease, with a forced expiratory volume in 1 second (FEV_1) of 28% of the predicted normal value, without bronchodilator response. Static lung volumes by body plethysmography were consistent with severe air trapping. Diffusing capacity was normal.

In October 2004, the patient was referred for an occupational pulmonary consultation. Paired inspiratory and

expiratory HRCT scans showed central peribronchial thickening with central airway dilatation and subtle areas of mosaic attenuation scattered throughout the lungs, predominantly in the right lower lobe. The diagnosis of work-related bronchiolitis obliterans was made on the basis of history, fixed airway obstruction with normal diffusing capacity, and typical HRCT findings (*7*). Diacetyl is considered the cause of this patient's disease on the basis of its known toxic effects; however, exposure to other less well-characterized flavoring chemicals might also have contributed.

Case 2. During 2002, a nonsmoking woman aged 40 years, who had no history of lung disease or respiratory symptoms when she began working as a flavor compounder, experienced nasal congestion and cough after 5 years on the job, which involved mixing dry powders with diacetyl and other ingredients to make artificial butter flavoring. The workplace did not have exposure-control measures such as local exhaust ventilation, and employees did not use respirators appropriately. The worker reported wearing a paper dust mask that had not been fit tested and did not provide adequate protection from either volatile organic compounds or particulates. The woman was treated with antibiotics and antihistamines by her primary-care physician. She experienced progressively worsening shortness of breath on exertion, decreasing exercise tolerance, and a nonproductive cough. In November 2005, she visited a pulmonary specialist who suspected work-related asthma and treated her with bronchodilators and oral corticosteroids, producing minimal improvement. An HRCT of the chest showed several small areas of patchy ground-glass opacities throughout the lungs.

In December 2005, the patient stopped working because of her respiratory symptoms. Spirometry revealed severe obstructive lung disease, with an FEV_1 of 18% of the predicted normal value, without bronchodilator response. Static lung volumes by body plethysmography were consistent with severe air trapping. Diffusing capacity was normal. Left thoracotomy with wedge resection of the left lower lobe did not indicate bronchiolitis obliterans in this area of the lung. However, other findings of peribronchial inflammation, interstitial fibrosis, and non-caseating–type granulomas suggested an inflammatory process. The diagnosis of work-related bronchiolitis obliterans was made on the basis of history, fixed airway obstruction with normal diffusing capacity, and typical HRCT findings (*7*).

Public Health Investigation and Response

In response to the two case reports, Cal/OSHA conducted enforcement investigations of the two companies in August 2004 and April 2006, respectively. The companies were required to conduct spirometry screening and reduce employee exposure to diacetyl and other flavoring ingredients using engineering controls (e.g., effective ventilation, improved work practices such as covering containers and minimizing spills), and protective respiratory measures (e.g., appropriate use of respirators with particulate filters and cartridges for protection against organic vapors). In April 2006, Cal/OSHA and CDHS implemented a cooperative intervention program to encourage the state's entire flavor-manufacturing industry to implement the same measures. CDHS used marketing databases, information from the Flavor and Extract Manufacturers Association, and a telephone survey to locate 26 additional flavor manufacturers statewide; the total of 28 companies is thought to represent this entire industry in California. All of the newly identified companies voluntarily agreed to participate in the program, which requires that they conduct medical surveillance of exposed workers, assess and control exposure to chemicals, and accept agency supervision of these activities.

The companies are in various stages of establishing their medical programs; by March 1, 2007, CDHS had received spirometry results for 419 of approximately 750 employees in the 28 companies (including the two companies in which the first two cases occurred). The Cal/OSHA consultation service is conducting or monitoring worksite industrial hygiene assessments for the participating companies and is evaluating data on exposure to airborne diacetyl and other chemicals. Industrial hygienists from CDC's National Institute for Occupational Safety and Health (NIOSH) have assessed exposures and developed guidance on work practices and exposure-control technology for three companies.

Since April 2006, five additional flavor-manufacturing workers have been identified with severe fixed obstructive lung disease, for a total of seven workers associated with four flavor manufacturers in California. None of the seven had ever smoked; one had a history of childhood asthma. Six (86%) were men. The mean age at which they first sought medical attention for respiratory problems was 34 years (range: 27–44). Six of the seven workers were employed as flavoring compounders who handled diacetyl and other chemicals when mixing flavorings; three made powdered flavorings only, and three prepared both liquids and powders. The seventh worker was a production worker who packaged powder flavorings. These companies did not have local exhaust ventilation to control chemical exposures. Six workers wore paper dust masks that were not fit tested and did not provide protection from volatile organic chemicals and particulates.

Symptoms reported by the seven workers included cough, wheezing, or shortness of breath on exertion, with onset ranging from 1 month to 5 years after beginning work in flavor manufacturing. FEV_1 ranged from 17% to 44% of predicted normal value for age, height, race, and sex, and the ratio of FEV_1 to forced vital capacity ranged from 30% to 61%. None of the FEV_1 values improved after bronchodilator administration. Initial diagnoses for these employees included asthma, bronchitis, and bronchiectasis.

In May 2006, CDHS disseminated outreach materials, including a diacetyl hazard alert and description of sentinel cases, to flavor manufacturers, health-care providers, and worker organizations (available at http://www.dhs.ca.gov/ohb/flavorings.htm). CDHS also obtained current material safety data sheets* from 11 diacetyl manufacturers or distributors and determined that five mentioned bronchiolitis obliterans, and none listed potential symptoms or recommended medical surveillance for the disease. In addition to the seven persons with identified bronchiolitis obliterans, 22 current workers with obstructive abnormalities detected by spirometry are being medically evaluated, and Cal/OSHA is assessing their occupational exposure to flavoring chemicals to minimize risk for disease.

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Editorial Note: The emergence of bronchiolitis obliterans in California flavor-manufacturing workers underscores the challenges faced by workers, employers, government agencies, and medical professionals in responding to newly identified work hazards. Bronchiolitis obliterans was first identified in flavor-manufacturing workers in 1985 (*8*), although the chemical etiology was not identified at that time. The hazards of diacetyl and butter flavoring were documented in published literature in 2002 (*1,3*). However, by 2006, many flavoring suppliers still had not addressed the risk for bronchiolitis obliterans in their material safety data sheets. During 2004, NIOSH and the Flavor and Extract Manufacturers Association disseminated information encouraging flavor manufacturers to implement exposure controls and medical surveillance (*9,10*). These measures were virtually nonexistent in California during 2006, when industrywide government intervention measures began. Before June 2006, only eight California flavor-manufacturing companies had begun medical screening.

Bronchiolitis obliterans and fixed obstructive lung disease in the workers described in this report were not recognized initially as work-related conditions even though they occurred in young, previously healthy persons who had never smoked and had no evident nonwork etiology. Frequently, workers with occupational lung disease have worsening respiratory symptoms at work or improvement of symptoms while on vacation. The lack of this work-related pattern of respiratory symptoms likely delayed identification of a work-related origin. Single, sporadic cases in workers of a rare disease such as bronchiolitis obliterans might not be diagnosed accurately by clinicians or might not be attributed to a work-related exposure; initial misdiagnoses might include asthma, bronchitis, emphysema, or bronchiectasis.

Safe occupational exposure levels for diacetyl and many other flavoring chemicals have not been established. Employers should implement measures to minimize exposure. Engineering controls, including local exhaust ventilation and closed transfer of chemicals, should be the primary control measures. Work practices such as covering containers and minimizing spills also will reduce exposures. Employers should establish a comprehensive respiratory protection program for organic vapors and particulates that adheres to the OSHA Respiratory Protection Standard (29 CFR 1910.134 available at http://www.osha.gov). Consultation with an industrial hygienist or occupational safety and health professional might be necessary to implement appropriate engineering controls, work practices, and an appropriate respiratory protection program.†

A better understanding of work-related risk factors for bronchiolitis obliterans in the flavoring industry will facilitate establishing priorities for preventive interventions. Cal/OSHA and CDHS will aggregate data from the 28 companies to identify manufacturing processes and types and concentrations of flavoring chemicals associated with occupational lung disease.

Evaluation of interventions to prevent bronchiolitis obliterans rely on early detection of abnormal spirometry results or unusual decreases in repeated measurements. Beginning in January 2007, with assistance from NIOSH, CDHS performed quality checks of submitted screening spirometry results. Many results did not meet American Thoracic Society quality criteria (available at http://www.thoracic.org/sections/publications/statements/pages/pfet/pft2.html).

* Material safety data sheets provide workers and emergency personnel with procedures for handling various substances and include information such as physical properties, toxicity, health effects from exposure, and spill or leak procedures. OSHA's Hazard Communication Standard requires persons who sell chemicals to provide material safety data sheets to inform their customers of hazards and safe-use practices.

† Information on respirators and selection of respirators is available at http://www.cdc.gov/niosh/npptl/topics/respirators and http://www.cdc.gov/niosh/docs/2005-100/default.html.

Flavor manufacturers and flavored-food producers are widely distributed in the United States. Bronchiolitis obliterans has been identified in microwave-popcorn workers in several states, including Missouri, Iowa, Ohio, New Jersey, and Illinois; bronchiolitis obliterans in flavor-manufacturing workers has been identified in Ohio, California, Maryland, and New Jersey. Although the risk for occupational lung disease has been established in the microwave-popcorn industry (*1,2*) and improvements have been made (e.g., isolating processes, increasing exhaust ventilation, and using respirators), the risk for occupational lung disease associated with the use of flavorings during production of other types of food has not been established. Additional information for physicians treating workers with respiratory disease who have been exposed to flavoring chemicals is available at http://www.cdc.gov/niosh/topics/flavorings, and assistance is available from NIOSH, OSHA programs, and state health departments.

Acknowledgments

This report is based, in part, on contributions by A Gelb, MD, and P Harber, MD, Div of Occupational and Environmental Medicine, Univ of California.

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Nonfatal Occupational Injuries and Illnesses — United States, 2004

Data collected through a National Electronic Injury Surveillance System occupational supplement (NEISS-Work) provide information on persons treated for nonfatal work-related injuries and illnesses in U.S. hospital emergency departments (EDs). CDC's National Institute for Occupational Safety and Health uses these data to monitor injury trends and aid prevention activities. This report summarizes 2004 NEISS-Work injury and illness surveillance data. In 2004, an estimated 3.4 million nonfatal ED-treated injuries and illnesses occurred among workers of all ages, with a rate of 2.5 cases per 100 full-time equivalent (FTE) workers aged ≥15 years. Workers aged <25 years had the highest injury/illness rates. More than three fourths of all nonfatal workplace injuries/illnesses were attributed to contact with objects or equipment (e.g., being struck by a falling tool or caught in machinery), bodily reaction or exertion (e.g., a sprain or strain), and falls. No substantial reduction was observed in the overall number and rate of ED-treated occupational injuries/illnesses during 1996–2004 (*1–3*). To reduce occupational injuries/illnesses, interventions should continue to target workers at highest risk and reduce exposure to those workplace hazards with the greatest potential for causing severe injury or death. More emphasis should be placed on prevention-effectiveness studies and dissemination of successful interventions to reduce work-related injuries and illnesses.

NEISS-Work uses a national stratified probability sample of 67 U.S. hospitals with 24-hour EDs.* Hospitals in the sample were selected from the approximately 5,300 rural and urban U.S. hospitals after stratification into four size-based strata (i.e., by total annual ED visits) plus a children's hospital stratum. Each injury/illness was assigned a statistical weight correlating to the probability of selecting the treating hospital within its sample stratum. Weights were adjusted monthly for nonresponse among the sample hospitals and on an annual basis for national fluctuations in ED usage. ED-usage adjustments for 2004 were derived from a sampling frame of national hospital ED visits in 2003.

* The NEISS-Work data collection system is operated by the Consumer Product Safety Commission (CPSC) as a supplement to its NEISS surveillance of consumer product–related injuries. CPSC product-related injury estimates exclude work-related injuries. NEISS-Work estimates include all work-related injuries regardless of product involvement. NEISS-Work uses approximately two thirds of the CPSC sample of 101 hospitals. Because of hospital closures and other nonparticipation/nonresponse factors, the number of reporting hospitals can vary monthly and yearly.