Case Report

How Many Deaths Will it Take? A Death From Asthma Associated With Work-Related Environmental Tobacco Smoke

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Background *Despite epidemiologic, experimental and observational data on the association of environmental tobacco smoke (ETS) and adverse health effects, bar and restaurant workers remain exposed to ETS in the majority of states and countries.*
Methods *Three public health surveillance systems were used to identify and conduct a follow-up investigation of a reported acute asthma death of a young waitress in a bar.*
Results *The waitress collapsed at the bar where she worked and was declared dead shortly thereafter. Evaluation of the circumstances of her death and her medical history concluded that her death was from acute asthma due to environmental tobacco smoke at work.*
Conclusions *This is the first reported acute asthma death associated with work-related ETS. Recent studies of asthma among bar and restaurant workers before and after smoking bans support this association. This death dramatizes the need to enact legal protections for workers in the hospitality industry from secondhand smoke.* Am. J. Ind. Med. 51:111–116, 2008. © *2007 Wiley-Liss, Inc.*

KEY WORDS: asthma; environmental tobacco smoke; work-related; bars and restaurants; asthma death

INTRODUCTION

Despite the evidence of the adverse heath effects of environmental tobacco smoke (ETS), bar and restaurant workers continue to be exposed to ETS at work in states and localities that have not passed smoke-free laws. The importance for protecting this group from involuntary exposure to this health hazard has recently been summarized [Eisner, 2006; Koh et al., 2007]. The 2006 Surgeon General's report, *The Health Consequences of Involuntary Exposure to Tobacco Smoke*: *A Report of the Surgeon General*, concluded that ETS causes coronary heart disease, lung cancer and premature death, but that the evidence was suggestive rather than sufficient to conclude the causal relationship of ETS and asthma exacerbations in adults [Office on Smoking and Health, 2006]. Recent studies have shown improvement in air quality for bar and restaurant workers after a smoking ban [Skogstad et al., 2006; Goodman et al., 2007]. This article describes findings from public health surveillance systems in Michigan that identified the workplace death of a young asthmatic waitress and then conducted a worksite investigation to determine factors at her workplace that may have caused or contributed to her death. Recent published studies of ETS and hospitality workers are reviewed in light of the probable association of her death with exposure to secondhand smoke at work.

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METHODS

Michigan has three public health surveillance systems that involve public health reporting and investigation of work-related asthma, two are for work-related conditions and one is for asthma deaths. First, occupational disease reports are collected and compiled based on the state Public Health Code mandate that health care providers, hospitals, clinics and employers report work-related illnesses [Reilly et al., 2006]. Second, in-depth evaluations of acute work-related deaths are conducted under a program funded in multiple states by the National Institute for Occupational Safety and Health (NIOSH) titled ''Fatal Assessment and Control Evaluation (FACE)'' [Rosenman et al., 2006]. Third, the state maintains a rapid asthma death notification and investigation system, called the Michigan Asthma Mortality Review (MAMR), to identify interventions to prevent future asthma deaths [Rosenman et al., 2007] The first two systems are maintained by a university that is a bona fide agent of the state and the third is administered by that university under contract to the state health department. Data sharing across the systems is conducted as allowed in the Public Health Code and approved by the Institutional Review Boards of the university and the state health department.

Mandatory Disease Reporting

Public health reporting of work-related diseases has been mandated since 1978 by the Michigan Public Health Code (Article 368, Part 56, P.A.1978 as amended). Similar to long-standing reporting requirements for infectious diseases, this law requires reporting of personal identifiers and, additionally, name and address of the person's employer, so that public health officials can follow back to collect additional information. Special public health surveillance initiatives for selected occupational diseases have been built on this reporting system including work-related asthma [Rosenman et al., 1997]. The asthma surveillance initiative includes in-depth interviews with reported cases to identify the exposure(s) that caused or exacerbated the asthma, collection of medical records and selected work-site follow-up by industrial hygienists from the Michigan Occupational Safety and Health Administration (MIOSHA) to evaluate and remediate exposure risks for both the index worker and co-workers.

Michigan FACE (MIFACE)

The objectives of the MIFACE program are to track the types of work situations where acute work-related deaths have occurred, identify the underlying causes of each reported work-related fatality, and formulate and disseminate prevention strategies to reduce work-related fatalities. Work-related deaths are identified from a number of data sources including death certificates, newspaper clippings, medical examiners, and the Michigan Occupational Safety and Health Administration (MIOSHA). Most deaths identified in the MIFACE program are traumatic fatalities, but acute deaths secondary to asphyxiants, carbon monoxide or chemical exposure, including work-related asthma deaths, are within the scope of the program. Once a work-related death has been identified and confirmed, an investigation is conducted to collect detailed information about the circumstances associated with the fatal event. Source documents are reviewed, including reports from other agencies that investigated the death (e.g., medical examiner, MIOSHA). MIFACE also contacts the employer to request permission to conduct an on-site investigation. MIFACE investigators do not enforce compliance with MIOSHA rules and do not assign fault or blame. A report is written at the conclusion of the investigation that describes the event and makes recommendations for prevention of similar events; this report is sent to the employer and other groups that can potentially effect work practice changes to eliminate or reduce the chances of a similar event in the future.

MAMR

Deaths where asthma is listed as the underlying cause of death are identified from the death data files at the Michigan Department of Community Health. Upon receipt of the death certificate the next of kin is contacted and if agreeable is interviewed. All medical, pharmacy, emergency response, and medical examiner records from the year prior to death are obtained. Information from the death certificate, autopsy, next-of-kin interview, and medical records are summarized for each case and provided for review by an expert advisory panel of physicians, nurses, asthma educators, and social workers. The panel identifies causal factors including those related to health insurance, co-morbidities, asthma triggers, medical utilization and medical care, and the panel provides recommendations for follow-up prevention actions.

The asthma death described here was identified and followed up under the mandates and established procedures of these three surveillance system. The case presentation and field investigation narratives were summarized from source material in the surveillance systems.

RESULTS

Case Presentation

A young adult asthmatic student and part-time waitress collapsed at the bar where she worked and was transported to a hospital emergency room where she was declared dead. Status asthmaticus was listed as the cause of death on the death certificate. An autopsy was performed; ''asphyxia secondary to acute asthma attack'' was listed as the cause of

death. No evidence of acute or chronic cardiac or neurologic disease was found. Pathologic findings for the lung were noted as follows: ''There is mild chronic bronchiolitis with a focal moderate interstitial eosinophilic infiltrate. Goblet cell hyperplasia and a distinctive 'saw-tooth' luminal morphology of some of the bronchiolar mucosa is identified. The bronchiolar lumens are variably filled with fibrinous exudates, small mucous plugs and foamy macrophages. There is congestion in the surrounding alveolar parenchyma. No smooth muscle hyperplasia or bronchiolar fibrosis is seen.''

The circumstances surrounding her death were as follows. When she arrived at work at mid-evening, she greeted her co-workers and talked with the DJ for approximately 15 min, who was setting up in a room adjacent to the bar. It was reported that she was not experiencing any difficulty breathing at this time and that she appeared ''jovial.'' She then walked about 25 feet to an open section of the bar. There were approximately 30 people in the bar area. Shortly after she went behind the bar, she grabbed the bar manager, saying she needed to get to the hospital and that she needed fresh air. She also stated she wished she had her inhaler with her. As the two walked out from behind the bar and toward the back door, she collapsed onto the dance floor. The bar patrons were asked if anyone had an inhaler. Someone did, and the victim attempted to use the inhaler, but was unable to do so. According to the bar manager, the inhaler mist came back into her face. After her collapse, the bar manager called the owner, who told the bar manager to call for an ambulance. The call was recorded by 911 at 21 min after her arrival at work. The ambulance arrived in 5 min. Emergency Medical Services (EMS) found her unresponsive, without a pulse, and with agonal respirations, which quickly stopped. The monitor showed asystole. CPR was started; EMS reported great difficulty trying to expand her lungs with an ambu-bag. When her airway was opened for intubation, 600–700 cc of clear fluid came from her mouth. Five hundred cubic centimetres were then suctioned from her airway, and she was then intubated without difficulty. When she arrived at the Emergency Department (ED) she was unresponsive and the monitor showed asystole. She had a pulse with chest compressions, and her pupils were fixed and dilated. An IV was started and advanced cardiac life support medications were given without a change in her condition. The code was ended at 30 min after the 911 call was recorded.

The patient had been asthmatic since age 2. She was under the care of an asthma and allergy specialist and had health insurance up until 6 weeks prior to death. She had made four visits to her physician in the year prior to her death, each of them for a ''flare up'' of her asthma, and she had been treated at the ED 2–3 times in that year. She had prescriptions for Albuterol, which she used in a nebulizer 3–4 times a week, Proventil MDI, Singulair, and Advair. However, she was reported to only use her medication when she was having breathing difficulty. Medical records from her outpatient visits were available for review and were consistent with moderate persistent asthma according to the National Heart, Lung and Blood Institute guidelines [NHLBI, 1997]. She had been treated at the ED approximately three times a year since age 5 and she had been in the ICU twice in her life, with one intubation.

Allergy testing showed that she had allergies to nuts, trees, ragweed, mold, dust mites, and house mites. She had never smoked cigarettes and did not drink alcohol or use illicit drugs. There were no pets in the home. She went to school in the morning, and worked at a fast food restaurant and the bar where she died. She was not prescribed antibiotics in the weeks before death and had no other ongoing medical problems. Based on her body mass index (BMI), she was obese.

Field Investigation

The bar where the decedent worked has been in business for approximately 3 years and employed approximately 11 people, 5 of whom were present at the time of the incident. The bar had two separate areas, including the bar area with limited seating and another room to the side with a DJ booth and a small dance floor, which was accessed from the bar through an opening half-way to the rear of the bar. The bar area, which was approximately 18 by 80 feet with doors at the front and rear, had seating for 39 patrons, 11 at the bar itself and 28 at seven tables. The front door was very near the area where the victim first began to have breathing problems. The owner described the ventilation in the bar area as having a ''smoke eater,'' which drew air from the patron seating area into a 2- to 3-foot high plenum above the drop. This drawn air was then discharged above the back door to the outside of the building. There were six rectangular fans laid on top of the vent panels, presumably to assist in the air discharge to the ceiling plenum. These fans were inexpensive air cooling fans one would purchase for home use rather than industrial exhaust fans (See Fig. 1). The ''smoke eater'' ventilation was reported to have been working, but the air cooling fans were not turned on at the time of the incident. The bar owner stated that the manager reported that the bar was ''not overly smoky'' at the time of the incident. The actual number of smokers among the 30 patrons present at the time was not known; however, the MIFACE investigator noted a pronounced tobacco smoke odor during her on-site investigation even though there were only a few patrons present, calling it a ''typical smoky bar.''

Two health and safety recommendations and their rationale were made in the MIFACE investigation report [Michigan State University, 2006]:

(1) Even though ventilation systems can reduce odor, they cannot guard against environmental tobacco smoke

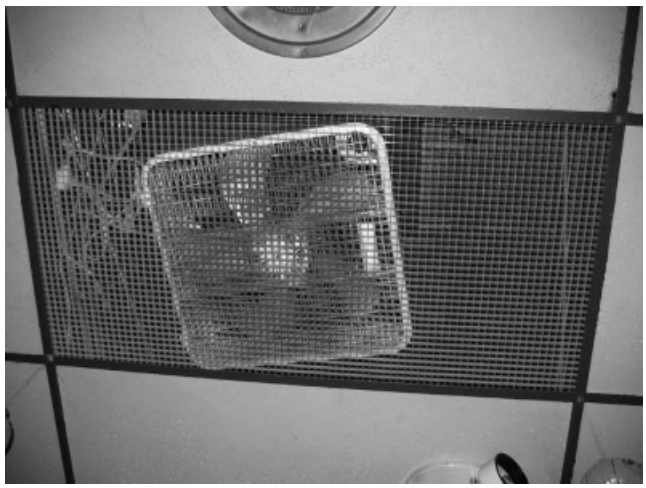

FIGURE 1. Fan laying on ceiling panel in bar area.

health dangers. Therefore, ''To protect the health of employees, private business owners, including bar and restaurant owners, should consider prohibiting smoking within their establishments.''

(2) The bar manager called the bar owner rather than calling 911 immediately when the crisis was unfolding, and potential life-saving minutes were lost. The owner had not developed an emergency plan or trained employees in appropriate response. Therefore, ''Business owners should develop, implement and train employees in the business' emergency response plan.''

DISCUSSION

Deaths from asthma are rare but alarming events. Risk factors for fatal asthma death include history of severe asthma attack requiring intubation and ventilation, poor compliance with outpatient management and medications, and psychosocial factors. Risk factors may be patient-related (e.g., poor compliance with prescribed medication), features of asthma (e.g., severe allergies, prednisone-resistance) medical-care-related (e.g., inadequate prescription of steroids, inadequate diagnosis, needed referral for high-risk patients), and system-related (e.g., psycho-social factors such as family dysfunction, poverty, and psychiatric disorders) [Strunk et al., 1998]. Secondhand smoke exposure was found to have moderately high risk (Odds Ratio = 7.1) for intubation among young adult asthmatics [LeSon and Gershwin, 1996].

Successful disease management techniques are available to provide control over asthma symptoms and a high quality of life. Identification and avoidance of the asthma triggers that provoke airway inflammation, including irritants and allergens, are among the key components of long-term control [NHLBI, 1997]. Tobacco smoke is a recognized respiratory tract irritant [LeSon and Gershwin, 1996; Office on Smoking and Health, 2006] and may promote an inflammatory process [Skogstad et al., 2006].

In the past 20 years there has been increasing evidence of the adverse effects of environmental tobacco smoke (ETS) on non-malignant respiratory disease in general and asthma specifically. In the 2006 Surgeon General's report, *The Health Consequences of Involuntary Exposure to Tobacco Smoke*: *A Report of the Surgeon General*, studies were reviewed covering etiologic, morbidity, experimental and observational studies of asthma and ETS. That report concluded that ''. . .the evidence is suggestive but not sufficient to infer a causal relationship between secondhand smoke exposure and a worsening of asthma control'' [Office on Smoking and Health, 2006]. The difficulties of conducting studies relating ETS to both pulmonary function and asthma were described in this and other reviews [Coultas, 1998; Weiss et al., 1999; Institute of Medicine, 2000]. Experimental studies, which have generated conflicting data, were limited by short exposure duration and small sample size. Observational studies were based on self-reports of ETS exposure and symptoms, and were subject to selection and recall bias. In addition, the contribution of workplace ETS exposures to overall self-reported exposure to ETS was not investigated.

Recent laws banning smoking in public places in a number of countries, states, and communities have provided an opportunity to conduct better studies of the effects of ETS on respiratory health in general and asthma in particular. Bars generally have high levels of cigarette smoke, and employees have long periods of exposure. Studies in Ireland [Goodman et al., 2007], Scotland [Menzies et al., 2006], Norway [Ellingsen et al., 2006; Skogstad et al., 2006], and Kentucky [Hahn et al., 2006] compared parameters of exposure and health outcomes including reported symptoms and lung function measures in bar/restaurant workers before and after the bans. All four studies included direct biological measures of ETS exposure: salivary, urinary or serum cotinine, or hair nicotine, and the Norway study measured air nicotine. In addition, total air particulate samples were taken in the Ireland and Norway studies. The usefulness of direct measures of ETS and their association with adverse respiratory outcomes had first been reported in a 2005 study, where nicotine badges and hair nicotine were used to measure exposure by a cohort of non-smoking asthmatics; the study found that directly measured ETS exposure was associated with poorer asthma outcomes [Eisner et al., 2005].

The studies in Ireland and Kentucky did not differentiate their findings related to the asthma status of their cohorts. In Ireland, concentrations of airborne particulate matter and salivary cotinine declined significantly, pulmonary function tests showed significant improvements, and respiratory

symptoms declined among nonsmoking barmen after the ban. In the Kentucky study, significant declines in hair nicotine and respiratory symptoms, particularly among non-smokers, were documented in the months after the smoking ban.

The studies in Norway and Scotland provided results on impacts to asthmatic workers, in addition to smoking and non-smoking workers in general. The Norway study measured cross shift changes in lung function and found that, among asthmatics, the decreases in FEV, FEV1, and $FEF_{25-75\%}$ were significantly larger across the workshift before than after the ban. Concentrations of total dust and nicotine declined significantly after the ban as well. Menzies et al. measured respiratory symptoms, spirometry measurements, serum cotinine levels, peripheral inflammatory cell counts, and exhaled nitric oxide levels before and after introduction of a smoking ban in Scotland among a group of non-asthmatic and asthmatic nonsmoking bar workers and found that bar workers with asthma experienced an even larger improvement in pulmonary function than those without asthma after the smoking ban. The addition of these studies of respiratory health and asthma in workers with high exposure to ETS further supports the evidence that ETS is a hazard and that people with asthma have an even greater risk.

This is the first reported acute asthma death associated with work-related ETS. Michigan is the only state with three surveillance systems that include overlapping mandates and responsibilities for public health response to work-related illnesses and injuries. This may explain why work-related asthma deaths from ETS have not been identified elsewhere.

Several limitations should be noted related to this case report. First, the deceased's asthma was not under optimum control; this would increase the likelihood of an adverse reaction with exposure to an asthma trigger. Second, there are no measurements of particulate matter in the bar where she died; thus the association with secondhand smoke is based on the temporal relationship of exposure to her acute respiratory symptoms and her subsequent collapse in the absence of any other know trigger for this acute effect. However, the epidemiologic and experimental data linking ETS to acute, non-malignant respiratory conditions including exacerbation of asthma, supports the clinical impression of an association.

Primary prevention to eliminate the risk of asthma exacerbation from ETS would be to make all workplaces, including bars and restaurants, smoke free. Workplaces should be accessible to all workers and patrons, including those with respiratory conditions. Patrons may have a choice when considering where to eat or drink, but the employees of those bars and restaurants do not have a choice, particularly in the low paying hospitality industry. To date, 17 states and dozens of municipalities in the United States have legislated smoke-free bars and restaurants [Koh et al., 2007]. Most of the provinces in Canada and Australia and eleven other countries are, or soon will be, completely smoke-free in bars and restaurants [ANRF, 2007]. Although the world has ''begun to reclaim clean air as the social norm'' [Koh et al., 2007], countless numbers of workers are still being involuntarily exposed, and legislative change requires continued perseverance. In the absence of smoke-free legislation, employers would be well off voluntarily adopting smoke-free policies, given that employers have been held legally liable for employee exposure to ETS [Zellers et al., 2007], and the evidence that smoke-free policies do not have a negative financial impact on bars [Alamar and Glantz, 2007].

A pro-smoking website has posted a statement that ''[T]he only real justification for a total ban [on smoking in public places] would be incontrovertible proof that environmental tobacco smoke is a deadly health hazard'' [Forestonline.org, 2007]. Environmental tobacco smoke was deadly to the patient presented here. Although it is doubtful smoking advocates would consider the proof ''incontrovertible,'' we find the circumstances of this death are convincing to conclude that this young woman died from exposure to work-related second hand smoke. Her death provides dramatic evidence of the need for smoke-free legislation to protect the health of bar and restaurant workers.

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