Evaluation of Indoor Environmental Quality in a Natural History Building

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Contents

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The cover photo is a close-up image of sorbent tubes, which are used by the HHE Program to measure airborne exposures. This photo is an artistic representation that may not be related to this Health Hazard Evaluation. Photo by NIOSH.

Highlights of this Evaluation

The Health Hazard Evaluation Program received a request from a university health and safety office regarding employees who worked in offices, computer workstations, and research departments that studied birds, mammals, and fish. These areas were on the seventh floor of a building that also housed a museum of natural history. The request concerned rashes, sore throat, and respiratory irritation that employees thought were work-related.

What We Did

- We evaluated the seventh floor of a university building in February 2014.
- We interviewed employees about their medical and work history and reviewed their medical records.
- We looked at work practices and workplace conditions.
- We measured temperature, relative humidity, and carbon dioxide concentrations.
- We examined the ventilation systems and observed air flow patterns.
- We reviewed industrial hygiene sampling for mold and chemicals done by the university.

We evaluated symptoms among staff on the seventh floor. Some had allergy-like symptoms that may be work-related. We did not find evidence of a single exposure for the reported symptoms from November 2011. The ventilation systems did not prevent spread of contaminants from specimen handling and storage. We recommended improving specimen handling and storage procedures, housekeeping, and ventilation.

What We Found

- In November 2011, four employees experienced a variety of symptoms within days of each other. We believe these incidents did not have a common source.
- In 2013, employees complained of a variety of symptoms. We believe some may be work-related and some may not.
- Temperature and relative humidity levels on the seventh floor were not within the recommended range for employee comfort.
- The ventilation systems on the seventh floor were well maintained.
- Employees did not always handle specimens in a ventilated cabinet or hood or in the biotic analysis lab.
- Air flowed out of the biotic analysis lab into surrounding areas.
- Some staff wore nitrile gloves while handling specimens.

What the Employer Can Do

- Adjust the ventilation system so air flows into the biotic analysis lab from the surrounding areas.
- Adjust the ventilation systems so allergens and other contaminants from specimen storage and handling areas do not move into adjacent offices.
- Keep temperature and relative humidity within comfort guidelines.
- Isolate the specimen storage and handling areas from other work areas.
- Improve housekeeping on the seventh floor.
- Develop procedures for storing, handling, and preparing specimens.
- Stop industrial hygiene sampling for molds and chemicals to determine the cause of employee symptoms.

What Employees Can Do

- Follow standard operating procedures for handling specimens, including using gloves and wearing a lab coat.
- Wash hands regularly, especially after working with specimens.

Introduction

The Health Hazard Evaluation Program received a request from a university health and safety office to evaluate employees' concerns about rashes, sore throat, and respiratory irritation when working on the seventh floor of a natural history building that housed offices, computer workstations, and animal research departments. During our site visit in February 2014, we evaluated indoor environmental quality conditions in the departments and interviewed employees and students about their work and health.

The seven-story limestone block building was constructed in 1901. A natural history museum and administrative offices occupied the lower floors. Additional administrative offices, computer workstations, and the ornithology, mammology, and icthyology departments occupied the seventh floor. Two rooftop variable air volume air handling units provided air-conditioning and heat for the seventh floor. The exterior windows could not be opened.

Work activities of the faculty, staff, and students on the seventh floor ranged from working in perimeter offices and at computer workstations to handling animal specimens, primarily birds. Hundreds of bird and mammal specimens were stored on the seventh floor in unventilated cabinets. The cabinets were specially designed to minimize internal temperature and relative humidity fluctuations to preserve the specimens. In preparation for shipment to the university, the specimens were eviscerated, preserved with heat, and packed with naphthalene-impregnated cotton to prevent bug infestations. Packed specimens were quarantined in the originating country while awaiting export permits to the United States, a process that could take months. Upon arrival at the university, specimens were processed on the seventh floor and added to the collection. Birds were the largest portion of newly arriving specimens and comprised the largest percentage of specimens stored on the floor. The specimen storage and processing areas were next to offices and computer workstations and shared the same ventilation systems.

Methods

Our objectives were to evaluate the indoor environmental quality in the seventh floor departments and identify workplace exposures or conditions that could be associated with reported symptoms. We looked for visual evidence of past or current water damage, water incursion, and mold on the seventh floor. We measured temperature, relative humidity, and carbon dioxide throughout the workday with a TSI Q-TRAK™ Plus Indoor Air Quality Monitor, Model 8554. We visually inspected the air handling units on the north and the south end of the building. We looked in both attics for evidence of animals or water incursion. We used ventilation smoke tubes to characterize airflow patterns between the biotic analysis lab and surrounding hallways.

The department provided a roster of all faculty, staff, and graduate students who worked on the floor, and we interviewed all individuals present during the evaluation. We asked about health issues they felt were related to working on the seventh floor and reviewed their daily duties. In addition, we took a complete medical history to determine if any medical issues could be unrecognized occupational illnesses that individuals had not previously linked to

their work. We requested medical records if individuals reported seeing a physician for health issues that they attributed to the seventh floor, unless we determined during the interview that the health issue reported was not likely related to the building.

We reviewed past environmental surveys conducted by university staff and their consultants. We asked about housekeeping practices and reviewed safety data sheets for the housekeeping products used.

Results and Discussion

Employee Health

Four employees had a variety of respiratory symptoms and rashes in November 2011. Although symptoms differed among employees, they thought that their symptoms might have a common source originating from the seventh floor. After reviewing all the provided information and interviewing the involved individuals, we believe these incidents did not have a common source. There were no further reported incidents until about 2013.

We interviewed 27 of 31 individuals on the roster of staff, faculty, and students provided by the university. Those interviewed had worked on the floor from 4 months to 27 years. Several people reported high air temperature and humidity levels indoors during the summer of 2013. Fifteen reported no symptoms or health issues that they related to working on the seventh floor. Three reported experiencing symptoms but were unsure if they were related to working on the seventh floor. Their symptoms were nonspecific and different from each other. Nine individuals reported symptoms they felt were related to working on the seventh floor. These included intermittent itchy eyes (5); throat irritation (3); cough (3); nasal symptoms like itching, sneezing, and congestion (2); itchy, prickly, or crawling skin (2); folliculitis, which is infection of the hair follicles (1); and new onset asthma (1). One of these nine individuals reported testing that showed allergies to common allergens, including feathers.

We reviewed the medical records for four of the 27 employees we interviewed. Three of the four had allergy testing; one was allergic to common allergens (not including feathers), one was allergic to cockroach, and one was not allergic to any of the test substances, which did not include feathers. Allergy testing was planned for the fourth employee. One individual was diagnosed with asthma on the basis of medical history and spirometry. However, we did not have enough information to determine if the asthma was related to work.

Although we are aware of allergy testing for only a few employees, it is possible that other people with symptoms were allergic to substances that may be present on the seventh floor. Fifteen people reported a pre-existing history of asthma, eczema, and allergic rhinitis (or hay fever). Persons with these allergic diseases are considered atopic, which means they have a genetic predisposition to developing allergies. Atopic individuals are more likely than nonatopic individuals to develop allergy to animal allergens. Five of these reported symptoms consistent with allergy related to work. It is probable, however, that some of the reported symptoms were not work-related. Six people reported pre-existing asthma that was unchanged when on the floor.

The faculty, staff, and students we interviewed had a heightened awareness of the suspected indoor environmental quality problems on the seventh floor. Such heightened awareness might lead individuals to notice symptoms they might otherwise overlook and to attribute them to the work environment. We have learned from prior indoor environmental evaluations that often symptoms reported by building occupants are wide ranging, do not suggest a particular medical diagnosis, and are not readily associated with a causative agent. Symptoms are influenced by cognitive (thought) processes [Bogaerts et al. 2010] and are more common when pollution or health threats are perceived, as on the seventh floor [Watson and Pennebaker 1989; Williams and Lees-Haley 1993]. Of the general population, 86%–95% have one or more common symptoms during any 2- to 4-week period. The average adult reports a minimum of one symptom every 4 to 6 days, and these symptoms are rarely caused by serious illness [Barsky and Borus 1995]. Researchers reported 1-year symptom prevalence rates from three populations in California. The top 10 symptoms were sinus congestion or sneezing, irritated eyes, allergies or asthma, headaches, fatigue, difficulty sleeping, numbness or tingling in limbs, and skin problems, with rates of 9.1%–30.4% [Lipscomb et al. 1992]. A similar study in Australia found the top 10 symptoms were stuffy nose, headaches, fatigue, cough, itchy eyes, sore throat, skin rash, wheezing, trouble breathing, and nausea, with rates of 10.1%–46.2% [Heyworth and McCaul 2001]. These common symptoms in the general population were among the most common symptoms reported by individuals on the seventh floor.

Ventilation

The two ventilation systems serving the seventh floor were well maintained. They were variable air volume systems. The 24″× 24″ × 2″ pleated air filters were in good condition and correctly installed. The minimum efficiency reporting value for these filters was not available. Cooling coils and condensate drainage pans were clean. On the day of this evaluation, air temperatures on the seventh floor were 67°F–73°F, within the ASHRAE recommended thermal comfort guidelines for the winter season [ANSI/ASHRAE 2010]. The outdoor temperature reached 37°F. Several staff reported indoor air temperatures on the seventh floor that were well above 73°F during the summer of 2013. During this evaluation relative humidity levels were 7%–16%, below the ASHRAE thermal comfort guidelines. Outdoor relative humidity reached 40% in the afternoon. Indoor carbon dioxide concentrations were 440–560 parts per million, and the outdoor concentration was 370 parts per million. We compare indoor and outdoor carbon dioxide concentrations to determine if indoor occupied spaces are adequately ventilated [ANSI/ASHRAE 2013]. For sparsely occupied work areas such as the seventh floor these carbon dioxide concentrations may not be an accurate indicator of ventilation adequacy. Regardless, carbon dioxide concentrations on the seventh floor were less than 700 parts per million higher than outdoor concentrations and conformed to recommended guidelines for carbon dioxide concentrations [ANSI/ASHRAE 2013].

During our evaluation employees mentioned concerns about high temperatures and humidity levels in the summer and low humidity in the winter. The facilities maintenance personnel responsible for the ventilation systems for this area of the campus described challenges to maintaining a comfortable environment. A portable dehumidifier, used to reduce humidity in late

summer 2013, remained in place but was not in use during our evaluation.

The air handling unit on the north end of the seventh floor had been renovated in 2012 to provide ventilation for a new biotic analysis lab. Unlike return air from the rest of the floor, exhaust air from the biotic analysis lab was not recirculated. Air was exhausted from the biotic analysis lab directly to the roof through a chemical safety hood and two exhaust air ducts. According to the university health and safety department manager, the lab was designed to meet biosafety level 2 criteria [CDC 2009], including a ventilation system designed to keep the new lab under negative pressure (meaning that air flowed into the lab from surrounding areas). Using ventilation smoke tubes we found that the biotic analysis lab was not kept under negative pressure consistently throughout the workday because the supply air rate to the lab varied while the exhaust air rate remained fixed.

Within the past year the facilities maintenance department was administratively divided into zone offices that were responsible for all regular building maintenance in a given zone. Employees and managers noted that after this change, adherence to maintenance schedules became less strict. According to the environmental health and safety manager, in July or August 2013 the air handling unit on the south end of the seventh floor had visible mold growth and debris on the air filters, heating and cooling coils, and condensate drainage pan due to poor maintenance. Following this discovery, the air handling units were cleaned and the maintenance frequency was increased.

Preventive maintenance and inspections of air handling units were scheduled quarterly. However, beginning in July 2013 new procedures required air handling units to be inspected monthly to address poorly controlled environmental conditions and identify microbial growth early.

Because animal specimens are sensitive to environmental fluctuations, department managers kept records of temperature and relative humidity levels on the seventh floor. We reviewed data from May through December 2013. One storage area had temperatures of 61.0°F–79.5°F and relative humidity of 14%–75% during this period. The highest relative humidity levels occurred in early October 2013, at which point facility maintenance personnel adjusted the air-conditioning system and relative humidity dropped to below 60%. Relative humidity levels declined further during the transition from fall to winter.

Exposures

Prior to our visit, the environmental health and safety manager hired consultants to perform environmental sampling. On separate occasions, the consultants sampled for volatile organic compounds in the air using evacuated canister samplers; allergens in surface vacuum samples; and mold in air and surface samples. We reviewed seven consultants' reports. Low levels of volatile organic compounds were found, including naphthalene (present in mothballs); however, none of the measurements approached occupational exposure limits or were at concentrations expected to present a health hazard. Cat allergen was found in vacuum samples from three locations on the south end of the floor. Generally, we do not recommend sampling for mold as results can be difficult to interpret with regard to health impact, and mold is ubiquitous in indoor and outdoor environments. Health-based

standards for acceptable levels of biological agents, including mold, in the air or surfaces have not been established.

Our review of safety data sheets for cleaning products used on the seventh floor showed that some contained irritants such as glycol ethers and fragrances. Every bathroom on the floor had a deodorizer. The university did not have a policy regarding fragrances in products used by housekeeping staff nor products used or worn by university faculty, students, or staff. Exposure to these cleaning products could contribute to reported symptoms.

Observations

Employees regularly removed animal specimens from storage cabinets. According to university faculty and staff, specimens were historically preserved with arsenic or other metal salts until the 1970s. Many of the older stored specimens, which were removed from storage cabinets for examination, could be contaminated with arsenic. We observed that not all individuals wore gloves when handling museum specimens. Those who did wore nitrile gloves. Specimens were not processed in the biological safety cabinet or ventilated chemical hood in the biotic analysis lab. Some individuals reported that museum specimens were handled outside the biotic analysis lab, for example, on tables in office areas. In addition, employees and students could bring animal allergens into the building from home.

Museum specimens were potential sources of allergens, including dander and feathers. In addition, environmental allergens such as pollens and molds from the acquisition site of the specimens could also be present. Because specimen storage areas were adjacent to and shared ventilation systems with offices and workstations, and specimens were handled outside biological safety cabinets or ventilated chemical hoods, we believe that there was an opportunity for potential spread of allergens and other contaminants. Department managers were preparing written protocols for handling animal specimens but had not yet finalized them.

The environmental health and safety department offered INOVEL, LLC Model 1500 Series N95 filtering facepiece respirators to some voluntary respirator users. It also provided these employees with a copy of Appendix D from the Occupational Safety and Health Administration respiratory protection standard as required. However, the environmental health and safety department was not provided with a complete list of employees and students who may voluntarily wear an N95 filtering facepiece respirator and some employee who wore respirators did not receive Appendix D. Employees wore the respirators out of concern about exposure to an unknown agent causing allergic-type symptoms in some floor occupants. We saw one person wearing an N95 filtering facepiece respirator upside down.

In September 2013, environmental health and safety staff found bat carcasses and mold in a closet. In response to the complaint, the university remediated the mold and renovated the closet and adjacent room, disposed of the bat carcasses, and sealed the bats' entry point. Employees reported seeing bats and squirrels indoors on the seventh floor over many years. They reported that the animals were entering the building through holes in the roof. However, we did not see evidence of animal habitations in our attic inspections.

Housekeeping staff cleaned offices and common areas one time per week. They were responsible for cleaning the floor, which was mopped with a hand-operated walk-behind machine, but did not clean surfaces such as shelves or desktops. The occupants were responsible for cleaning surfaces other than floors in their office or other work spaces and did so at their own discretion. The floors on the seventh floor were tiled or bare concrete. The university provided concentrated cleaning chemicals for housekeeping staff use. Depending on where housekeeping staff worked on campus they diluted the product themselves or they received ready-to-use solutions from a central dilution location. Bathrooms were cleaned five times per week. Students and staff had a commercial shop vacuum and hand brush available in the biotic analysis lab to clean up debris after working with specimens on the laboratory bench. The vacuum was not equipped with a high-efficiency particulate air filter. Dry sweeping can cause allergens or other contaminants to be entrained into the air and spread more easily, and insufficient filtration can cause the contaminants to be released in the vacuum exhaust.

Conclusions

We found no evidence of a single workplace exposure responsible for the November 2011 incidents among four employees. Allergy to animal allergens was likely responsible for some of the ongoing symptoms, but many of the non-specific symptoms reported by the employees are common in the general population, so attributing them to specific allergens is difficult. The biotic analysis laboratory was not consistently under negative pressure relative to the surrounding areas. This means allergens could potentially migrate out of the biotic lab into hallways and work areas. Although the ventilation systems on the seventh floor were well maintained, they were not designed to minimize the migration of animal allergens and other contaminants potentially released during the handling and storage of specimens to adjacent offices and computer workstations.

Recommendations

On the basis of our findings, we recommend the actions listed below. We encourage the departments to use a labor-management health and safety committee or working group to discuss our recommendations and develop an action plan. Those involved in the work can best set priorities and assess the feasibility of our recommendations for the specific situation on the floor.

Our recommendations are based on an approach known as the hierarchy of controls. This approach groups actions by their likely effectiveness in reducing or removing hazards. In most cases, the preferred approach is to eliminate hazardous materials or processes and install engineering controls to reduce exposure or shield employees. Until such controls are in place, or if they are not effective or feasible, administrative measures and personal protective equipment may be needed.

Elimination and Substitution

Eliminating or substituting hazardous processes or materials reduces hazards and protects employees more effectively than other approaches. Prevention through design, considering elimination or substitution when designing or developing a project, reduces the need for additional controls in the future.

1. Work with university managers to use less irritating housekeeping products and cleaners. Resources for finding safer products can be found at http://cdph.ca.gov/programs/ohsep/Documents/GS-ELStandards.pdf and http://www.cdc.gov/niosh/docs/2012-126/.
2. Establish a no-fragrances policy in the workplace, including in bathrooms.

Engineering Controls

Engineering controls reduce employees' exposures by removing the hazard from the process or by placing a barrier between the hazard and the employee. Engineering controls protect employees effectively without placing primary responsibility of implementation on the employee.

1. Physically isolate the specimen storage and handling areas from other work areas. Remove specimen storage cabinets from computer workstations and offices.
2. Redesign the ventilation system to limit migration of allergens from specimen handling, and storage areas to office and computer work areas. The design(s) should also control temperature and relative humidity levels within thermal comfort guidelines on the seventh floor, thus eliminating the need for auxiliary portable dehumidifiers [ANSI/ASHRAE 2010, 2013].
3. Maintain the biotic analysis lab under negative pressure relative to surrounding areas at all times.
4. Handle specimens in the ventilated biological safety cabinet or chemical hood in the biotic analysis lab whenever possible.

Administrative Controls

The term administrative controls refer to employer-dictated work practices and policies to reduce or prevent hazardous exposures. Their effectiveness depends on employer commitment and employee acceptance. Regular monitoring and reinforcement are necessary to ensure that policies and procedures are followed consistently.

1. Develop written, standard protocols for handling animal specimens for students and faculty. Once finalized, provide training on these procedures. The National Institute for Occupational Safety and Health (NIOSH) provides guidelines for preventing asthma and allergies caused by exposure to animal specimens and animal products. This information should be incorporated into animal specimen handling protocols; it can be found at http://www.cdc.gov/niosh/docs/97-116/default.html. Additionally, the

Centers for Disease Control and Prevention publishes laboratory design and practice guidelines for controlling microbial hazards; these guidelines would also be effective in controlling the migration of allergens. These guidelines can be found at http://www.cdc.gov/biosafety/publications/bmbl5/BMBL5_sect_IV.pdf.

2. Encourage employees to wash hands regularly, especially after working with specimens.
3. Increase frequency of housekeeping to at least three times per week, use vacuums equipped with high-efficiency particulate air filters, and eliminate dry-sweeping as a cleaning option in the biotic analysis laboratory.
4. Discontinue environmental sampling for chemical and biological agents as a means to identify a cause for symptoms among faculty, staff, and students.
5. Adhere to the preventive maintenance and cleaning schedule for air handling units that serve the seventh floor and correct deficiencies such as mold growth and debris promptly.
6. Refer employees with continued symptoms to the University's occupational health physician.

Personal Protective Equipment

Personal protective equipment is the least effective means for controlling hazardous exposures. Proper use of personal protective equipment requires a comprehensive program and a high level of employee involvement and commitment. The right personal protective equipment must be chosen for each hazard. Supporting programs such as training, change-out schedules, and medical assessment may be needed. Personal protective equipment should not be the sole method for controlling hazardous exposures. Rather, personal protective equipment should be used until effective engineering and administrative controls are in place.

1. Require employees to wear lab coats and gloves when working with specimens.
2. Provide all staff who voluntarily wear N95 filtering facepiece respirators with Appendix D from the Occupational Safety and Health Administration respiratory protection standard 1910.134 (Information for Employees Using Respirators When Not Required Under Standard).

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