DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

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Chief, Environment of Care/Safety
John J. Pershing Veterans Affairs Medical Center
1500 North Westwood Blvd.
Poplar Bluff, MO 63901

Dear Ms. Miller:

This letter is in response to a union request for the National Institute for Occupational Safety and Health (NIOSH) to conduct a health hazard evaluation at John J. Pershing Veterans Affairs Medical Center (VAMC) located at 1500 North Westwood Boulevard in Poplar Bluff, Missouri. The request cited concerns for poor indoor environmental quality in the hematology and chemistry laboratory areas including condensation from air ducts and vents, debris and mold blowing from ventilation ducts, high relative humidity, moisture and mold concerns, and concerns for overall poor ventilation. Reported health symptoms included employees becoming sick from visible mold debris and having elevated mold antibodies.

BACKGROUND

The John J. Pershing Veteran's Administration Medical Center provides primary care, specialty, and mental health services. The chemistry laboratory area and hematology laboratory area are the areas of concern for this request. The requestors expressed concerns for a history of condensation from air ducts and vents, debris and mold blowing from ventilation ducts, high relative humidity, moisture and mold concerns, and concerns for overall poor ventilation in the chemistry and hematology laboratory areas. Requestors reported health concerns related to mold exposure and elevated mold antibodies, specifically elevated level of serum IgE antibodies to *Cladosporium*.

Several indoor environmental quality and mold testing results were shared by requestors along with photographs of the affected areas and several work orders. These reports are summarized below in approximate chronological order. Shared photos ranged from October 2018 through July 2022. The images show areas of potentially pooled water on the hospital roof and black debris on surfaces throughout the laboratory areas. Screenshots of text messages dated February 17, 2022, were also shared, and contain images and conversations about the black debris on surfaces in the laboratory areas. TempTrak temperature and relative humidity monitoring system data from January 2022 through September 2022 was shared for the hematology and chemistry areas. According to the shared information, at times, relative humidity readings exceeded 60% relative humidity in the hematology and chemistry areas.

Mold Testing, 2019

Mold Armor® testing kits were used by the union to collect samples in January 2019 and March 2019. These kits are advertised to allow testing for the presence of mold in 48 hours and can be mailed-in for lab analysis to determine the mold type. Samples were sent to BBI Test Labs, the laboratory Mold Armor uses. One swab sample (sample # 10065783) was reportedly collected from the second-floor chemistry lab on January 17, 2019, and the mold identification report indicated *Aspergillus* spp. was identified. Another swab sample (sample # 10083120) was reportedly collected outside from the north exterior wall of the hospital on March 25, 2019, and the mold identification report indicated *Rhodotorula* spp., *Candida* spp., *Cladosporium* spp., *Aspergillus* spp., and *Alternaria* spp. were identified.

Indoor Environmental Quality Report, 2019
On January 29, 2019, John A. Jurgiel and Associates conducted a limited indoor air quality survey at John J. Pershing VAMC at the request of hospital management. The purpose of the survey was to evaluate current conditions in the hematology lab and blood bank, and the chemistry lab and c-wing hallway were evaluated for comparison purposes. Surface samples were collected using tape-lift or bulk sampling techniques from various representative building materials that appeared to be affected with mold growth. Airborne mold spore samples were collected using Burkard Mold Spore Traps, factory calibrated to a flowrate of 10 liters per minute. All samples were analyzed by direct microscopic methods by EMSL Analytical, Inc., of St. Louis, Missouri, a laboratory accredited by the American Industrial Hygiene Association (AIHA) for environmental microbiology. Results from the report (dated February 11, 2019) of the indoor air quality survey are summarized below.

Hematology Lab (Room 2C-048)
The report states at the time of survey no obvious water stains or intrusions were observed; however, black particulate or debris were observed on various surfaces and laboratory equipment and a black discoloration on an air supply grille on the ceiling was pointed out by one of the laboratory technicians. Two tape-lift samples were collected in this area. Sample VPBL-T1 was collected from loose black particulate that was observed on instruments and other surfaces around the Coagulation Station in the Hematology Lab (Room 2C-048). The report results identified high amounts of *Cladosporium* spores and hyphal fragments; and rare (very low) amounts of *Alternaria*, basidiospores, and pollen. The report notes the identified particulate was not observed to be growing on the sampled surfaces but was dislodged from another location. Sample VPBL-T2 was collected from the ceiling tile grid with black discolorations above the Coagulation Station in the Hematology Lab (Room 2C-048). The report results identified rare (very low) amounts of *Pithomyces* and fibrous particulate.

Chemistry Lab (Room 2C-046)
The report states at the time of the survey, no obvious water stains or water intrusions were observed; however, a water-stained ceiling tile was observed above one of the chemistry analyzers. The report states, it was suspected the water-stained ceiling tile was likely related to an isolated water leak associated with the perimeter steam lines.

Blood Bank (Room 2A-037A)
The report states at the time of the survey, no obvious water stains or water intrusions were observed; however, dark discolorations were observed on a small piece of broken ceiling tile, and similar discolorations were observed on top of the remaining ceiling tile. A bulk sample was later collected from the broken ceiling tile. Sample VPBL-T3 was collected from black

discolorations on the broken ceiling tile lying on top of the suspected ceiling in the Blood Bank (Room 2A-037A). The report notes tape-lift results identified high amounts of *Alternaria* spores, hyphal fragments; and very low amounts of *Cladosporium* spores.

Airborne Mold Spore Sample Results
Eight airborne mold spore samples were collected during this survey including four outdoor control samples and samples from the hematology lab (VPBL-1), chemistry lab (VPBL-2), c-wing (VPBL-3), and blood bank (VPBL-4). The report noted that mold spore types detected in the four indoor samples were similar to those mold spore types detected in the outdoor, control samples; with a slight amplification of hyphal fragments noted in the hematology lab. The report by Jurgiel and Associates, Inc. summarized that based on the air sampling results no indoor amplifications of airborne mold spores were detected in the affected areas.

Report Summary
The report by Jurgiel and Associates, Inc. was sent to Timothy Lowe at John J. Pershing VAMC. The report provided conclusions and recommendations based on reported conditions and observations at the time of the survey. Conclusions and recommendations included mold remediation, general cleaning, duct cleaning, investigating sources of water leaks or potential condensation, and monitoring temperature and relative humidity levels.

Additional email exchanges from Jurgiel and Associates, Inc. from February 2019 were shared with NIOSH, and include bulleted summaries of report results and a recommendation that an investigation be conducted by a mechanical engineer of the ventilation system serving the hematology and chemistry labs. Arbitration transcripts for the arbitration hearing in the matter of case no. 200327-05154 were also shared. The arbitration transcripts are related to the ventilation recommendations shared by Jurgiel and Associates, Inc. to individuals at the John J. Pershing VAMC.

Indoor Environmental Quality Report, 2021
On September 10, 2021, Riverfront Safety & Health, LC (RSH) conducted a targeted indoor air quality survey in the second-floor laboratory areas at the request of hospital management. A visual assessment was performed to identify any moisture damage or mold growth on building materials. Surface samples were collected using tape-lift or bulk sampling techniques. Air samples were collected on an Air-O-Cell sampling cassette, with air drawn through the cassette using a calibrated air sampling pump. The report (dated October 5, 2021) states air samples were delivered to and analyzed by EMSL Analytical, Inc., of St. Louis, Missouri, for total mold spore count, including viable and non-viable spores. Data on temperature, relative humidity, carbon dioxide, carbon monoxide, and total volatile organic compounds (VOCs) was also collected. Results from this targeted indoor air quality screening by RSH are summarized below.

The report states "nearly all functional spaces were observed to be in a relatively dry state and with no visible microbial growth or other indoor air quality concerns with the following exceptions: the southeast corner of the 2FL [2nd floor] lab area exhibited elevated moisture levels (~ 70% relative moisture content) along the wall near the east ceiling. No visible mold growth, active water leaks or condensation were noted at the time of the site visit." The report noted, a commercial grade dehumidifier was observed in operation during RHS's assessment, and workers reported unfavorable humidity conditions when the dehumidifier was not operating. RSH noted the dehumidifier drain line was fed to an open-ended PVC drainpipe without a p-trap.

RSH reported indoor air quality conditions appeared relatively normal, with the following conditions observed and documented:

Air Sampling Results
Air samples identified in the report as *Lab Southeast* and *Lab Southwest* were noted to exhibit air concentration of *Aspergillus/Penicillium* in excess of the background and control air sample collected from the outdoors. It was noted in Table 2 of the report that any air concentration of *Aspergillus/Penicillium* would have exceeded the outdoor air sample concentrations because they were not detected in outdoor air samples.

Tape-lift Surface Sampling Results
Tape-lift sample results from the report stated: a tape-lift sample collected from visible discoloration observed on the lab counter paneling beneath the northwest corner sink exhibited "rare (i.e., 1–10 spore counts per area analyzed)" levels of basidiospores; a tape-lift sample collected from visibly stained sections the southeast wall exhibited "rare" species of *Alternaria* (*Ulocladium*), basidiospores, *Bipolaris*, *Curvularia* and *Epicoccum*; and a bulk sample of the actual drain tube from the lab's urinalysis machine exhibited "medium (i.e., 101–1000 spore counts per area analyzed)" species of basidiospores, "high (i.e., >1,000 spore counts per area analyzed" species of *Cladosporium* and "rare" species of *myxomycetes*.

General Indoor Air Quality Conditions Results
The RSH report summarized general indoor air quality conditions recorded at the time of the survey. The reported results were as follows: temperature 70.2° F, relative humidity 54.1%, dew point temperature 52.9° F, carbon monoxide 2 parts per million (ppm), carbon dioxide 493 ppm, and total VOCs 0.00 ppm. The total VOCs reading, although displayed as 0.00 ppm, was likely below the instrument's detection limit.

Report Summary
The report by RSH was sent to Vincent Adams at John J. Pershing VAMC. The report provided conclusions and recommendations based on observations at the time of the survey. Conclusions and recommendations addressed investigating water intrusion and removing water damaged plaster wall section in the second-floor laboratory areas, installing a p-trap for the dehumidifier drain, installing the urinalysis drain line tubing to operate as a closed system, replacing ventilation system filters, and monitoring sources that might contribute to poor indoor air quality such as food storage, mini-fridges, and cleaning products.

Occupational Safety and Health Administration (OSHA) Inspection, 2021
OSHA completed an onsite inspection (Inspection No. 1548989) at John J. Pershing VAMC on August 19, 2021, in response to a complaint alleging employee exposure to fungi in the Hematology, Chemical, and Blood Bank rooms of the laboratory. An OSHA official with the St. Louis Area office conducted the inspection which included a review of submitted documents, results from two third party contractors who conducted mold sampling, sampling events conducted by OSHA, and employee interviews. OSHA conducted air sampling for mold on October 05, 2021. A letter (dated January 28, 2022) describing OSHA Inspection No. 1548989 was sent from William McDonald, CSP, Area Director to Kimberly Adkins, Associate Medical Center Director, John J. Pershing VAMC. The letter stated that fungal colony forming units from mold air sampling were elevated in areas where exposure to fungi were of greatest concern when

compared to non-suspect areas. OSHA provided recommendations for preventing mold growth in occupied areas, preventing mold and bacterial growth in the building's ventilation system, cleaning the building's air ducts, protecting building occupants during building renovations or remodeling, and selecting a qualified professional who can assist in providing a safe and healthful work environment. On February 2, 2022, the hospital facility received the Hazard Alert Letter from OSHA and air sampling results and provided written responses to each of the OSHA recommended elements back to OSHA on March 18, 2022.

Management responses to OSHA included details related to the following:

- Maintenance schedules to ensure roof drains are inspected and cleaned as necessary.
- The process for responding to reported concerns and initiating work orders.
- Water Intrusion and Mold Management program.
- Training relevant staff on the Water Intrusion and Mold Management program.
- Veteran's Affairs Mold Awareness course which can help train employees.
- Monitoring temperature and relative humidity.
- Preventative maintenance and operating procedures for the ventilation system.
- Personal protective equipment if there is a reasonable accommodation request.
- Employee Occupational Health services.

Requestors submitted a complaint to the U.S. Department of Labor (DOL), Office of Inspector General (OIG) alleging an OSHA official with the St. Louis Area office, falsified a report describing OSHA Inspection No. 1548989 regarding workplace safety and health hazards at the John J Pershing VA Medical Center located at 1500 N Westwood Boulevard in Poplar Bluff, Missouri. The allegations were reviewed by the OIG's Office of Investigations – Labor Racketeering and Fraud (OI-LRF), and it was determined by the Special Agent-in-Charge to refer the complaint to OSHA management for review and any action deemed appropriate. OIG requested that OSHA management officials provide a response directly to requestors and OIG upon completion of their review. Requestors also shared their concerns with the Government Accountability Office.

Mold Test Performed, 2022

The requestor shared a standalone linear spore trap and surface sample analysis report provided by Air Care™ Companies, Inc. The union collected the samples following the My Mold Detective Test Kit Manual. My Mold Detective uses the Air Care™ Companies, Inc laboratory for testing collected samples. The following results were contained in the report:

- Sample Name: Outdoor (SN 208365, air sample). Spore Identification: *Penicillium/Aspergillus* Group (493 spores/cubic meter [spr/m^3]), basidiospores (2,646 spr/m^3), ascospores (987 spr/m^3), and *Cladosporium* (45 spr/m^3).
- Sample Name: 2C046 (SN 208364, air sample). Spore Identification: *Penicillium/Aspergillus* Group (718 spr/m^3) and basidiospores (1,211 spr/m^3).
- Sample Name: 2A055 (SN 208379, air sample). Spore Identification: *Penicillium/Aspergillus* Group (404 spr/m^3) and basidiospores (897 spr/m^3).
- Sample Name: 2C048 (SN 208381, air sample). Spore Identification: *Penicillium/Aspergillus* Group (135 spr/m^3) and basidiospores (224 spr/m^3).

- Sample Name: COAG 2C048 (SN 1420240, surface sample). Spore Identification: *Cladosporium* Species (rare), *Penicillium/Aspergillus* Group (low), and basidiospores (moderate).
- Sample Name: Vent 2 2C046 (SN 1420215, surface sample). Spore Identification: Smuts, *Periconia*, *Myxomycetes* (rare), basidiospores (rare), *Penicillium/Aspergillus* Group (rare), *Cladosporium* Species (rare), and *Alternaria* Species (rare).
- Sample Name: Vent 2 2C046 (SN 1420238, surface sample). Spore Identification: *Penicillium/Aspergillus* Group (rare), basidiospores (rare), *Nigrospora* Species (rare), *Curvularia* species (rare), Smuts, *Periconia*, *Myxomycetes* (rare), *Spegazzinia* Species (rare), and *Cladosporium* Species (moderate).
- Sample Name: Wall 2C046 (SN 1450465, surface sample). Spore Identification: Pollen (rare), Hyphae (rare), *Penicillium/Aspergillus* Group (rare), *Cladosporium* Species (rare), and Smuts, *Periconia*, *Myxomycetes* (rare).

Management Documents and Response Actions
On July 13, 2022, I spoke with you and others within hospital management to discuss the health hazard evaluation request. During our call, several participants on the phone call shared their awareness of concerns for indoor environmental quality concerns in the hematology and chemistry laboratory areas. Members of the call shared that in response to employee concerns there have been updates to standard operating procedures (SOP), and there are plans to update the ventilation system. It was also shared that the hospital hosted visits from OSHA, the joint commission, and external reviewers to evaluate indoor air quality.

The following documents in response to employee concerns were presented:
- Ventilation Design Document, July 2009
- Indoor Air Quality Policy, March 2018
- Jurgiel and Associates, Inc. Indoor Air Quality Report, January 2019
- Mold Remediation Plan, April 2019
- Indoor Air Quality Program, September 2020
- SOP for Indoor Air Quality Investigation Guidance, December 2020
- RSH Indoor Air Quality Assessment Report, September 2021
- Procedure for the temperature and humidity monitoring system, December 2021
- OSHA Hazard Alert Letter, January 2022
- Work Order for # PAC220216-001 to change filters for the lab unit, February 2022
- Safety Response after the OSHA inspection and reported concerns for debris, February 2022
- Work Order for # PAC220216-001 to change filters for the lab unit, February 2022
- HVAC Design Manual Rev., March 2022
- Mold Safety Plan Meeting Outline, March 2022
- Air Handler Unit Procedures, March 2022
- Response Memo to OSHA, March 2022
- Incident Report for sprinkler piping leak in laboratory 2C-048, May 2022
- Statement Of Work for Project # 657A4-19-701, Emergent – Remediate Mold in Lab
- Infection Control Risk Assessment Form for Water Intrusion and Mold
- Water Intrusion and Mold Management Program

The documents provided details on actions by management to address concerns for reported indoor environmental quality concerns in the laboratory areas.

DISCUSSION

I provide information below, as well as recommendations for further actions that might improve the indoor environmental quality at John J. Pershing VAMC. Recommendations are meant to supplement—not replace—any federal, state, local, territorial, or tribal health and safety laws, rules, and regulations with which facilities and businesses must comply.

Building Ventilation and Indoor Environmental Quality

Poor ventilation in buildings is a common problem and is frequently due to lack of proper attention to the building's heating, ventilation, and air conditioning (HVAC) system. HVAC systems include all the equipment used to ventilate, heat, and cool the building; to move the air around the building (ductwork); and to filter and clean the air. These systems can have a significant impact on how pollutants are distributed in and removed from spaces. They can even act as sources of pollutants in some cases, such as when ventilation air filters become contaminated with dirt and/or moisture, when microbial growth results from stagnant water in drain pans, or from uncontrolled moisture inside of air ducts.

Ventilation System Design

The air delivery capacity requirements of an HVAC system are based in part on the projected number of people and the area of the occupied space. Proper distribution of ventilation air throughout all occupied spaces is essential. When areas in a building are used differently than their original purpose, the HVAC system may require modification to accommodate these changes. For example, if a storage area is converted into space occupied by people, the HVAC system may require alteration to deliver enough conditioned air to the space.

Outdoor Air Supply

Design standards for air exchange rates, temperature, and relative humidity for health care facilities may differ from standards for other buildings [ASHRAE 2013]. An adequate supply of outdoor air, typically delivered through the HVAC system, is necessary in any indoor environment to dilute pollutants that are released by equipment, building materials, furnishings, products, and people. Tables 7.1, 8.1 and 9.1 in the *ANSI/ASHRAE/ASHE Standard 170-2021, Ventilation of Health Care Facilities,* provide air exchange rate, temperature, and relative humidity guidelines for areas of in-patient hospital, outpatient hospital, and residential health spaces, respectively [ANSI/ASHRAE/ASHE 2021]. For instance, patient rooms should be ventilated with at least four total air changes per hour (ACH) and at least two of those air changes should be with fresh, outdoor air. There is no recommendation for the pressure relationship between patient rooms and adjacent spaces. Most diagnostic and treatment areas, including most laboratory spaces, should be ventilated at 6 total ACH with at least two of those air changes being fresh, outdoor air. The majority of spaces within diagnostic and treatment areas should also be maintained under negative pressure relative to adjacent areas of the facility. Pharmacy areas should be ventilated at 4 total ACH, with at least 2 of those changes being fresh, outdoor air. Pharmacies do not have temperature or relative humidity recommendations, but they should be maintained under positive pressure relative to adjacent spaces. Resident gathering/activity/dining rooms should receive a minimum of 4 ACH of fresh, outdoor air and be maintained at temperatures between 70°F and 75°F. Toilet and bathing rooms should receive 10 total ACH and be maintained under negative pressure. Refer to Tables 7.1, 8.1 and 9.1 in

Standard 170-2021 for ventilation design parameters for other applicable healthcare spaces, including many support and service areas [ANSI/ASHRAE/ASHE 2021].

Guidelines for areas that are not specified in ANSI/ASHRAE/ASHE 170-2021, *Ventilation of Health Care Facilities,* should be obtained from *ANSI/ASHRAE Standard 62.1-2019, Ventilation for Acceptable Indoor Air Quality* [ANSI/ASHRAE 2019]. When areas of the facility have recommended rates in both Standard 170-2021 and Standard 62.1, the higher of the two air exchange rates should be used [ANSI/ASHRAE/ASHE 2021]. ANSI/ASHRAE 62.1-2019 makes ventilation recommendations in a slightly different way. Standard 62.1-2019 recommends outdoor air supply rates that take into account people-related sources as well as building-related sources. For office spaces and conference rooms, five cubic feet per minute of outdoor air per person (cfm/person) is recommended for people-related sources, and an additional 0.06 cfm for every square foot (cfm/ft2) of occupied space is recommended to account for building-related sources. Kitchens should receive 7.5 cfm/person plus 0.12 cfm/ft^2 of fresh, outdoor air. To find rates for other indoor spaces, refer to Table 6-1 which is found in ANSI/ASHRAE 62.1-2019 [ANSI/ASHRAE 2019]. ASHRAE provides solid guidance on outdoor air requirements, and their standards are generally incorporated into legally-enforceable building codes. However, there are occasions that the ASHRAE guidance may differ from state and/or local mechanical codes. Therefore, care should be taken to meet the ventilation requirements most appropriate for your locality and building type.

Carbon dioxide (CO_2) is a normal constituent of exhaled breath; thus, CO_2 will also increase during building occupancy. CO_2 levels are routinely collected in air quality studies because they can indicate whether a sufficient quantity of outdoor air is being introduced to an occupied space for acceptable odor control. A rule of thumb is that indoor CO_2 concentrations no greater than 700 parts per million (ppm) above outdoor CO_2 concentrations will satisfy a substantial majority of building occupants. This would typically correspond to indoor concentrations below 1200 ppm since outdoor CO_2 concentrations usually range from 375 to 500 ppm. However, CO_2 is not an effective indicator of ventilation adequacy if the ventilated area is not occupied at its usual occupant density at the time the CO_2 is measured. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased. If CO_2 concentrations are elevated, the amount of outdoor air introduced into the ventilated space may need to be increased.

In some cases, building owners/managers or occupants will open doors or windows to increase the amount of outdoor air coming into their building. However, relying on open doors may cause problems. For example, the air coming into the building through the doors may not reach all of the office areas in the building. The incoming air is unfiltered and may contain outdoor air pollutants such as pollen and dust. Additionally, open doors may affect the ability of the HVAC system to adequately control temperatures and humidity.

Exhaust Rates

For healthcare spaces where airborne contaminants and odors are prevalent, ANSI/ASHRAE/ASHE 170-2021 includes guidelines on which spaces all ventilation air should be exhausted directly outdoors, for instance, all air supplied to toilet and bathing rooms should be exhausted outdoors and not recycled. Most laboratory spaces should similarly be exhausted directly outdoors. Exhaust air from other spaces previously mentioned can be recycled, if necessary [ANSI/ASHRAE/ASHE 2021]. For spaces not covered in Standard 170-2021, ANSI/ASHRAE 62.1-2019 offers minimum exhaust rates from the space. To control humidity and odors, employee or public bathrooms and shower areas should exhaust more air than the air handling unit is supplying. This will maintain these areas under negative pressure so that air from surrounding spaces travels into the bathroom/shower areas and not allow airflow the opposite direction. Separate exhaust fans should be used to exhaust air directly outside at least 25 feet from any air intakes or areas where people gather (outdoor break areas, parking lots, etc.). There should be no recycling or re-entrainment of return/exhaust air from the bathrooms and shower rooms. For high occupancy bathrooms, the ANSI/ASHRAE Standard 62.1-2019 states that 50 cfm per water closet should be exhausted, unless periods of high occupancy are expected. In that case, 70 cfm per water closet should be exhausted [ANSI/ASHRAE 2019]. For private bathrooms designed for only one person at a time, 25 cfm should be exhausted if the exhaust fan runs continuously. If the fan runs intermittently (e.g., exhaust fan power controlled by the light switch), 50 cfm should be exhausted when the fan is operational. For shower rooms, the exhaust ventilation should be 20 cfm per showerhead if the exhaust fan is designed to operate continuously or 50 cfm per showerhead if the exhaust fan only operates intermittently [ANSI/ASHRAE 2019]. For areas containing both water closets and showers, the exhaust requirements are additive. Residential kitchens should exhaust 50 cfm if the exhaust fans operate continuously or 100 cfm if the fans operate intermittently [ANSI/ASHRAE 2019]. The makeup air for this exhaust air can consist of any combination of outdoor air, recirculated air, or air transferred from adjacent spaces.

Outdoor Air Quality
When present, outdoor air pollutants such as carbon monoxide, pollen, and dust may affect indoor conditions when outside air is taken into the building's ventilation system. Properly installed and maintained filters can trap many of the particles in outdoor supply air. Controlling gaseous or chemical pollutants may require more specialized filtration equipment and sometimes relocation of the outdoor air intakes. Section 4 of ANSI/ASHRAE Standard 62.1 specifies that any outdoor air brought into occupied spaces must be in compliance with the U.S. Environmental Protection Agency’s (EPA) National Ambient Air Quality Standards (NAAQS). The standard further stipulates that a local outdoor air quality assessment should be conducted at a building and the immediate surroundings during periods the building is expected to be occupied to identify and locate contaminants of concern. If any outdoor contaminants exceed the NAAQS limits, the outdoor air must be appropriately treated prior to introduction of that air to the occupied spaces.

Maintenance of HVAC Equipment
Diligent maintenance of HVAC equipment is essential for the adequate delivery and quality of building air. All well-run buildings have preventive maintenance programs that help ensure the proper functioning of HVAC systems.

HVAC Duct Cleaning
We do not recommend duct cleaning unless it is found to be contaminated with mold or other irritant particles affecting the employees’ health. Improper duct cleaning can release large amounts of dust and other contaminants into the work area. Fiberglass ductwork that has mold growth must be replaced; it cannot be cleaned. If metal duct cleaning is deemed necessary, it should only be performed by contractors who are members in good standing of the National Air Duct Cleaners Association. Enclosed is a fact sheet from the National Institutes of Health (NIH) on HVAC Duct Cleaning [NIH 2015].

Temperature and Relative Humidity

Temperature and relative humidity measurements are often collected as part of an indoor environmental quality investigation because these parameters affect the perception of comfort in an indoor environment. The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperature. Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. For healthcare-specific spaces, ANSI/ASHRAE/ASHE Standard 170-2021 includes some guidelines. Patient rooms should be maintained between 70°F and 75°F with relative humidity controlled below 60%. Bathing rooms should also be maintained between 70°F and 75°F and no recommendation is given for relative humidity. Temperatures in most diagnostic and treatment areas should also be maintained between 70°F and 75°F, while relative humidity recommendations are not given for most spaces of this type. For spaces not included in Standard 170-2021, *ANSI/ASHRAE Standard 55-2020: Thermal Environmental Conditions for Human Occupancy* specifies the combinations of indoor environmental and personal factors that produce acceptable thermal conditions to a majority of occupants within a space [ANSI/ASHRAE 2020]. Assuming slow air movement (less than 40 feet per minute) and 50% indoor relative humidity, the operative temperatures recommended by ASHRAE range from 68.5ºF to 75ºF in the winter, and from 75ºF to 80.5ºF in the summer. The difference in temperature ranges between the seasons is largely due to clothing selection. ASHRAE Standard 62.1 also recommends that indoor humidity be maintained to provide a maximum indoor-air dew-point temperature of 60 ºF in buildings that are mechanically cooled, during occupied and unoccupied periods [ANSI/ASHRAE 2019]. Using indoor-air dew-point temperature to limit humidity limits the total mass of water vapor available for condensation and adsorption on surfaces indoors. Condensation and adsorption of water on surfaces is largely responsible for indoor microbial growth. For other mechanical system types or where spaces are not served by mechanical systems, Standard 62.1 has no humidity limitations. The EPA recommends maintaining indoor relative humidity between 30% and 50% to reduce mold growth [EPA 2021].

Dampness and Mold in Buildings

Research has found that damp building conditions can lead to respiratory illnesses in building occupants. Dampness in buildings can occur for a variety of reasons such as high indoor humidity, condensation, and roof leaks. Damp building conditions promote the growth of mold, bacteria, and other microbial agents, as well as dust mites and cockroaches. Dampness can also contribute to the breakdown of building materials and furniture. Musty odors are a sign of microbial contamination. Building occupants in damp buildings can be exposed to pollutants in the air from biological contaminants and the breakdown of building materials

Building-Related Symptoms and Illnesses

Comprehensive reviews have been conducted of previous scientific studies evaluating the development of health effects associated with exposures from damp indoor conditions. The findings include sufficient epidemiological evidence of associations with upper and lower respiratory symptoms, asthma development and exacerbation, respiratory infections, allergic rhinitis, bronchitis, and eczema as well as clinical evidence of association with hypersensitivity pneumonitis [Mendell et al. 2011; WHO 2009]. There was limited or suggestive evidence of association with allergy/atopy [Mendell et al. 2011]. NIOSH has published an Alert, *Preventing Occupational Respiratory Disease from Exposures Caused by Dampness in Office Buildings, Schools, and Other Nonindustrial Buildings.* Although not specific for hospitals, the enclosed

Alert provides information on respiratory disease related to indoor dampness and recommendations for preventing and remediating damp buildings [NIOSH 2012].

Air Sampling

NIOSH does not typically recommend air sampling for mold with building air quality evaluations. There are no U.S. health-based exposure limits for biological contamination set by the Occupational Safety and Health Administration (OSHA) or recommended by NIOSH. Measurements of mold in air are highly variable and dependent on the mold species' lifecycle stages (e.g., spore formation) [NIOSH 2012]. In many cases, short-term sampling for mold spores is conducted; however, the results might not be representative of actual exposures. Furthermore, spore counts and culture results, which tend to be what are included in indoor air quality reports, do not capture the full range of exposures. What building occupants react to is largely unknown. It can be mold, a compound produced by mold, something related to bacteria, or compounds that are released into the air when wet building materials break down. We have found that thorough visual inspections or detection of problem areas by musty odors are more reliable. These methods have been used in past NIOSH research and have shown a correlation with health risks in buildings that have indoor environmental complaints.

Dampness and Mold in Healthcare Facilities

In hospitals, the presence of dampness and mold presents multiple hazards. Dampness and mold can cause damage to building structures and materials and can also cause healthcare-associated infections (HAIs). All patients are susceptible to contracting HAIs from microbial airborne agents such as mold and bacteria. However, immunocompromised patients, who have a deficient immune response because of immunologic disorders, chronic diseases, or immunosuppressive therapy (e.g., organ transplant and cancer patients), are at the greatest risk [Sehulster et al. 2003, last updated July 2019]. Exposure to microbial agents such as mold and bacteria also can cause building-related symptoms among healthcare workers. In 2000, NIOSH evaluated respiratory symptoms and asthma in employees in relation to indoor dampness at two hospitals. NIOSH found that work-related symptoms in hospital employees were associated with diverse exposures including mold and bacteria. Additionally, the findings suggested onset of building-related asthma in relation to water damage [Cox-Ganser et al. 2009].

Diligent building maintenance and good housekeeping procedures are important. Hospitals often have maintenance issues or renovation projects that may require walls or ceilings to be opened or removed, which creates an opportunity for microbial agents such as fungal spores or fragments to be released into the hospital environment. To lessen the health risks to healthcare workers and patients, precautions should be taken to prevent microbial agents from becoming airborne during maintenance, renovation, or construction projects. Prior to construction, demolition, or renovation projects, an infection control risk assessment should be conducted to determine the extent of any mold and the proper steps and barrier measures needed to limit and prevent exposure. Appropriate engineering controls in patient rooms also play a major role in assisting in the removal of particulates from the air and preventing exposure to microbial agents.

The Centers for Disease Control and Prevention (CDC) and the Healthcare Infection Control Practices Advisory Committee (HICPAC), a federal advisory committee assembled to provide advice and guidance to the CDC, developed guidelines for environmental infection control in healthcare facilities [Sehulster et al. 2003, last updated July 2019]. The document provides environmental infection control strategies and engineering controls to prevent infections from microbial agents. As noted in the document, infections can be minimized by the

1) appropriate use of cleaners and disinfectants;
2) appropriate maintenance of medical equipment;
3) adherence to water-quality standards;
4) adherence to ventilation standards for specialized care environments (e.g., airborne infection isolation rooms, protective environment, operating rooms); and
5) prompt management of water intrusion into the facility.

Implementing routine inspections of the facility for dampness can help to identify trouble areas and to prioritize maintenance and repair. As a resource for monitoring dampness in buildings, I have enclosed the *NIOSH Dampness and Mold Assessment Tool.* The tool provides an inexpensive mechanism to track, record, and compare conditions over time. The assessment form and associated instructions can also be downloaded from the NIOSH website (https://www.cdc.gov/niosh/docs/2019-115/) [NIOSH 2018]. Additionally, a summary of the assessment form, how to use the form, and how to interpret data collected using the form is freely available online (https://www.mdpi.com/2075-5309/12/8/1075) [Park and Cox-Ganser 2022]. If dampness or mold is not identified during visual inspections but is suspected because of musty/moldy odors or continued health complaints, other methods, such as looking in wall cavities and under flooring, should be considered to look for hidden problems. Using moisture meters and infrared cameras can also sometimes identify sources of dampness.

Remediation

Wetted materials need to be dried within 48 hours of getting wet to prevent mold growth, and necessary repairs need to be made to prevent further water entry into the building. If mold is identified on materials, appropriate remediation guidelines with proper isolation and containment are recommended to minimize exposure to building occupants. The enclosed document, *Guidelines on Assessment and Remediation of Fungi in Indoor Environments*, developed by the New York City Department of Health and Mental Hygiene (NYCDH&MH), provides guidance for cleaning mold-damaged materials [NYCDH&MH 2008]. Inappropriate remediation (e.g., painting over water-damaged materials or moldy surfaces) can cause further problems with building degradation and symptoms or infections in healthcare workers and patients. The CDC/HICPAC guidelines for environmental infection control in healthcare facilities also has recommendations of actions to take during construction, renovation, remediation, repair, and demolition [Sehulster et al. 2003].

After Remediation

After repairs and remediation are completed, employees and management often wish to know if the building is "safe." Building consultants often recommend and perform "clearance" air sampling after remediation work has been completed in an attempt to demonstrate that the building is safe for occupants. However, there is no scientific basis for the use of air sampling for this purpose. Once remediation is completed (moldy and damaged materials removed; musty odors no longer evident), the best evidence that the building is safe may be that employees no longer experience building-related symptoms. In large populations of workers, using employee health questionnaires may be helpful to collect information on building-related symptoms, particularly among persons new to the building after remediation (i.e., those without "sensitizing" historical exposures during a period of water damage). Unfortunately, even if most employees experience improvement in their symptoms, and new employees remain free of building-related symptoms, some employees with allergic conditions may not notice an improvement because their immune systems may continue to react to very small amounts of allergens. Such individuals may have to avoid the building even after an otherwise successful remediation. An individualized management plan (such as assigning an affected employee to a different work location, perhaps at home or a remote site) is sometimes required, depending upon medical findings and recommendations of the individual's physician.

Communication

NIOSH frequently finds a breakdown in communication between management and employees regarding building-related problems. Health and safety committees incorporating employee input can be helpful when dealing with indoor environmental issues. OSHA has helpful guidance on recommended practices for safety and health programs at https://www.osha.gov/shpguidelines/index.html

RECOMMENDATIONS

1. Consider consulting with an HVAC specialist to ensure the ventilation system is operating optimally for the laboratory areas.

2. Follow the HVAC manufacturer's recommended maintenance schedules, including replacing air filters, checking drip pans, ensuring thermostats are in working order, and checking and cleaning ventilation system dampers to ensure proper functioning. In addition, make sure water does not pool on the roof near the ventilation system fresh air intakes or anywhere fresh air intakes are located.

3. Maintain indoor temperature and relative humidity levels according to the guidelines discussed.

4. Ensure protocols are being followed to prevent debris from entering the ventilation ductwork when maintenance is performed on the system. If debris continues to enter the ventilation ductwork, inspect the ventilation system to identify factors contributing to debris in the ventilation system and correct these upon discovery.

5. If dehumidifiers are used, ensure they are cleaned and maintained according to the manufacturer's recommendations.

6. Routinely inspect the building for water intrusion and damage and correct these upon discovery. During and after heavy rains, walk through the building and check for water incursion.
   a. Identify any potential sources of dampness or mold through visual inspection and make proper repairs to prevent further problems from occurring.
   b. If dampness or mold is not identified during visual inspections but is suspected because of musty odors or continued health complaints, consider other methods to look for hidden problems such as under flooring or in wall cavities. Also, thermal imaging, with an infrared camera, after heavy rains can be used inside and outside buildings to look for leaks.

c. Keep a record of when and where mold or water-damaged materials are discovered and what has been done to promptly fix the underlying problem leading to the water damage.
d. Monitor repaired areas to ensure repairs and remedial actions are effective.

7. Any mold and moisture-damaged materials should be removed or cleaned with the appropriate containment to minimize exposure for remediation workers, building occupants, and unaffected sections of the building. Please review the enclosed NYCDH&MH guidelines on assessment and remediation of fungi. The CDC/HICPAC guidelines for environmental infection control in healthcare facilities also has recommendations of actions to take during construction, renovation, remediation, repair, and demolition [Sehulster et al. 2003, last updated July 2019].

8. If a communication system does not currently exist, establish a communication system with building tenants and employees when building-related issues arise. Information on response actions, including repairs or exposure and environmental assessment reports, should be provided to building occupants.

This letter will serve to close this health hazard evaluation. NIOSH recommends that copies of this letter be posted by management in a prominent place accessible to the employees for a period of 30 calendar days. If you have any questions, please contact Alyson Fortner at (304) 285-5851 or afortner@cdc.gov.

Sincerely,

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Enclosures
DOHS fact sheet on HVAC duct cleaning – NIH
NIOSH Alert: Preventing Respiratory Disease from Exposures Caused by Dampness and Mold in Office Buildings, Schools, and Other Nonindustrial Buildings – NIOSH
Dampness and Mold Assessment Tool for General Buildings – NIOSH
Guidelines on Assessment and Remediation of Fungi in Indoor Environments – NYCDH&MH

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