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Healthcare Facilities and Wildfire Smoke Impacts

John Martinelli, Michelle Rosales, David Brinkerhoff, Sylvia Fontes
Forensic Analytical Consulting Services

Wildfire Pollutants and Hospital Indoor Air Quality

Wildfires continue to ravage the west coast. Mandatory evacuations have been ordered, properties have been destroyed and the toll on human lives and wildlife has been devastating. In times of disaster, as people seek relief and a sense of safety and security, questions about outdoor and indoor air quality often arise. Healthcare facilities are a place we rely on to be a safe haven, however, they are not immune to the impacts of wildfire smoke on indoor environmental quality. Common questions asked during and shortly after a large wildfire event are, 1) “Is the air quality in the hospital safe for the workers?”, or 2) “Is it safe for patients?”.

The first question is somewhat easier to answer. Hospitals are highly engineered environments. Heating Ventilation Air Conditioning (HVAC) systems manage building pressures to ensure that the majority of outdoor air entering a hospital is filtered before entering the building rather than entering through doors and windows, as can be the case in other types of buildings such as residential buildings. Additionally, hospital air filters which may have a Minimum Efficiency Reporting Value (MERV) rating of 14 are significantly more efficient at removing contaminants than those found in other buildings such as homes, stores, fitness centers, theaters, schools or office buildings. In addition to these controls, the indoor environment in hospitals is designed for easy cleaning and is thoroughly and frequently cleaned. Even with all these control measures, outside air, and some of the airborne particles it transports will enter the hospital building. What does enter can be quickly removed with filtration and cleaning. Chances are the hospital indoor environment is better than other indoor environments healthcare workers might find themselves in and certainly is better than being outdoors.

The question of patient safety is more complicated. It is important that discussions related to patient safety include clinicians that are familiar with the patient health risks and the activities that will occur. These discussions should also include experts providing input on how to assess the performance of building systems and testing for the presence of contaminants in the indoor environment. As with staff members, patients in general will find themselves in a better environment when inside a well functioning and frequently cleaned hospital. However, certain clinical activities may be temporarily postponed until outdoor conditions have improved. For example, having patients exert physical effort for clinical testing, such as walking on a treadmill, might fall into this category while having an examination by an Ophthalmologist might be fine.

While particles associated with wildfires might contain toxins or act as irritants, in general, infectious pathogens such as mold spores are not an immediate concern. However, it is not uncommon for outdoor mold spore concentrations to become elevated after the fire, as previously covered soils are exposed and then buffeted by wind. As such, the HVAC filtration performance and indoor cleaning may need to be considered. It is important that a multidisciplinary team be activated to assess building performance, environmental risks, planned clinical activities, and the potential impact to patients and sensitive staff.

Some changes to HVAC system performance that are often discussed are changing to more efficient filters, adding carbon filters to the system, increasing the number of filter changes or reducing the amount of outdoor air being delivered into the building. While adding more efficient filters such as MERV 16 or HEPA filters may seem like a good way to reduce the amount of particles into the building, the existing systems may not be able to perform with the more restrictive filters in place.

Due to high particle levels in the air, the existing filters may become clogged more rapidly. Changing the filters out more frequently may be necessary. However, as the filters become clogged with particles, for a period of time they may become more efficient at filtering particles. Activated carbon, or charcoal filters may help reduce some odors but are not designed to prevent particles from passing through. Reducing the amount of outdoor air entering the building may have a positive effect on limiting particles indoors. If a system normally operates with a ratio of 80% outside air and 20% recirculated air and the system is tuned to restrict the outside air to 50% and the other 50% is recirculated air, the amount of outdoor particulate entering the building may be reduced. However, it will be important to ensure important air balances remain within the desired ranges and it may be important to consider the potential for carbon dioxide levels to increase inside the building. It may be preferable to have slightly higher CO_2 levels in the building if a reduction of wildfire smoke particles is achieved, for the short term. However, CO_2 can also be harmful, so this must be carefully considered and may require some additional monitoring.

Other things that can be done to help reduce the impact of wildfire smoke on the indoor air include where feasible, have the outer entry doors close before proceeding through the inner doors on dual door vestibules so that both sets of doors are not open at the same time. Roll up doors should be kept closed except when receiving shipments. If roll up doors are opened, other doors leading from the receiving area should be kept closed as much as possible. Access into and out of the building can be temporarily routed through a single entry. All other doors remain closed, perhaps sealed with painters tape and staff to redirect traffic and open the doors in the event of an emergency. Where dual entry door vestibules are not available, installation of a temporary vestibule that acts as an ante room may be helpful. This can be constructed like a temporary construction area containment and equipped with a HEPA filtered local exhaust unit to scrub the air in the ante room.

In general, when assessing impact to the indoor environment, efforts should include visual assessments of the HVAC systems, evaluation of cleaning methods and frequency and perception of odors. It should be documented that the HVAC system is working properly, that cleaning is thorough and frequent and that no odors are being noticed or reported. Environmental testing may also be helpful to evaluate indoor air quality or confirm cleaning efficacy depending on the facilities level of impact.

What is in that smoke?

Wildfire smoke is made up of a complex mixture of gases, vapors and fine particles (i.e., soot) produced when wood and other organic matter burn. Among the substances found are gases from partially burned hydrocarbons (e.g., carbon monoxide) and potentially toxic or irritant volatile organic compounds (e.g., acrolein, formaldehyde). If structures are involved, smoke can also include other chemicals such as hydrogen cyanide, polychlorinated biphenyls (PCBs) and dioxins, to name a few.

When evaluating impact to a hospital from a nearby wildfire, fire and smoke-related particulates (char, ash, and soot) are the most prevalent indicators. Wind driven fire and smoke related particulates can settle on exterior and interior surfaces of a structure. Typically, they accumulate at points of entry (e.g., windows, door) and potentially move towards the interior based on the routes of entry and level of impact. During assessment of wildfire impact, these combustion-related particulates are typically the easiest to visually see, collect, analyze and characterize. Fire and smoke-related particulates are defined as follows:

- Char is a partially burned piece of material that can be identified by morphology, color, relative opacity, fracture pattern, structure, and other characteristics.
- Ash is the leftover residue following complete combustion.
- Soot is a black carbonaceous substance produced during incomplete combustion.

Knowing what is in the smoke from a specific fire can help establish post cleanup testing methods and criteria. National standards that tell us how clean is clean enough are unavailable at this time. However, some criteria have been developed to help assess impact from a fire to the indoor environment and post cleanup cleanliness.

How and when should we clean?

The level of cleaning is dependent on the level of impact. In general, the first steps usually involve increasing indoor air pressure (i.e., positive) through HVAC system adjustments to reduce the amount of air entering through exterior entry points (e.g., doors and elevator shafts). Air filters generally become more efficient as they capture additional particles; however, there is a limit to the amount of particulate that can accumulate on them. Filters may need to be replaced to prevent them from collapsing or separating from the housing and allowing unfiltered air to bypass the filters.

Thorough cleaning of surfaces regularly during a fire event and shortly thereafter is recommended in the interior of the facility. Wiping of non-porous surfaces is generally effective however, using a HEPA vacuum on porous surfaces may be needed when visible particulate or odors are present. A professional restoration contractor may be of assistance in this regard if heavy accumulations of fire and smoke related particulates are observed. Frequent cleaning and increased efforts to improve indoor air quality may be needed for some time following a wildfire. Cleaning of ductwork is generally not needed, except for extreme cases where there are significant amounts of visible debris present in systems.

Odors are best addressed through cleaning or disposal of contaminated material. Products that purport to “eliminate” odors frequently only mask one odor with another, and in doing so contribute additional chemicals into the indoor air. The use of ozone to eliminate odors in buildings is rarely recommended. Ozone masks odors by deadening the sense of smell, can damage building materials, and can react with other compounds to produce toxic byproducts. The Environmental Protection Agency document, "Ozone Generators that are Sold as Air Cleaners: An Assessment of Effectiveness and Health Consequences" provides additional information related to ozone.

Occupants returning to buildings or fire damaged areas are likely to notice odors and experience health symptoms from contaminants in the outdoor environment. This frequently leads to increased concerns about indoor air quality in general, even to agents not associated with fires. Prompt and competent responses to these concerns can frequently prevent them from growing into widespread issues or claims.

In the wake of previous fire events, FACS has been asked by clients to support recovery efforts in a number of ways, including:

- assessing impact and making clean-up recommendations.
- conducting sampling/assessment to verify acceptable clean-up.
- Conducting real-time monitoring of particulates and carbon monoxide.
- surveying destroyed or damaged structures for asbestos, lead and other potential hazards.
- consultation on resolving indoor air quality concerns, including general training and education.
- litigation support.

We're here if you need us

At Forensic Analytical Consulting Services (FACS), our passion is protecting the health of people, families, communities and the environment through assessment, education and prevention. We are standing by to provide our services as needed or to simply answer your questions (310-668-5600). Please do not hesitate to contact us for assistance.

Additional Resources:

https://www.cdc.gov/disasters/wildfires/index.html

https://www.osha.gov/dts/wildfires/additional.html

http://calfire.ca.gov/communications/downloads/fact_sheets/BeforeDuringAfter.pdf

https://www.ready.gov/wildfire-toolkit

http://www.readyforwildfire.org/After-a-Wildfire/