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CD Summary

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THE BURNING ISSUE: HEALTH EFFECTS OF WILDFIRE SMOKE

Some say the world will end in fire
Some say in ice.
From what I've tasted of desire
I hold those that favor fire...

--Robert Frost

Oregon has seen a substantial increase in wildfire activity during the past few years. Aside from direct threats to safety posed by fires encroaching on towns and residential communities, air quality can also be an issue. The health effects of wildfire smoke are determined by several factors: the composition of the smoke, the intensity and duration of the exposure, and the susceptibility of the person exposed, which, in turn, is influenced by a person's age and underlying health conditions.

This *CD Summary* reviews the potential health effects of wildfire smoke, discusses who is at highest risk, and provides strategies to prevent exposure when the smoke gets thick.

COMPONENTS OF WILDFIRE SMOKE AND THEIR HEALTH EFFECTS

Wildfire smoke is a concoction of gases, particles, and a bunch of chemicals. Among the gases, perhaps the greatest health concern is carbon monoxide (CO), a colorless, odorless gas that has an affinity for hemoglobin >200 times that of oxygen. This means that, if CO is present in any appreciable amount, oxygen-binding capacity of hemoglobin is lowered, and people can get hypoxic very quickly. Wildfire-related CO exposure is primarily limited to people who are close to fires, particularly in areas where the main fire has passed, combustion was incomplete, and smoldering continues.[1] Fire fighters tend to be at highest risk.

The aromatic hydrocarbons in wildfire smoke are the same sorts of chemicals that one might be exposed to from auto exhaust or tobacco smoke (and many other sources, for that matter). They aren't typically associated with acute health effects, but cumulative exposure over time appears to increase the risk for several types of malignancies.[2]

Smoke also contains particulate matter. Some of these particles are relatively large, that is, greater than 10µm, and are typically are filtered

out in the nose and upper airways. These larger paticless are primarily associated with "nuisance" symptoms such as stinging eyes, nasal irritation, and a scratchy throat. Particles between 2.5µm and 10µm (coarse particles, $PM_{10-2.5}$) can make their way deeper into the bronchi and bronchioles, triggering cough, and, in those with underlying lung conditions, such as chronic obstructive pulmonary disease (COPD) and asthma, trigger acute exacerbations.[3]

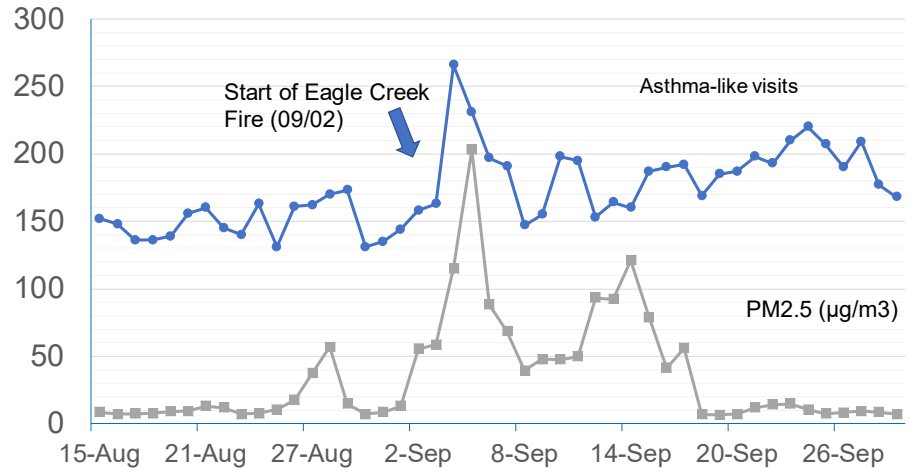
Particles smaller than 2.5µm in diameter — commonly called $PM_{2.5}$ or fine particles — can penetrate deep into the lungs where they can enter the bloodstream.[4] Once there, they can have several pernicious effects: increasing the risk of arrhythmia; triggering inflammation; increasing platelet viscosity; and making rupture of atherosclerotic plaques more likely, all of which increase the risk of myocardial infarction. In a recent study, exposure to wildfire smoke was associated with increased risk of emergency department visits for cardiovascular, cerebrovascular, and respiratory outcomes, particularly in the elderly.[5]

A review of studies focusing on non-occupational exposure to wildfire smoke from the U.S. and Australia found substantial evidence for particulate matter-associated respiratory morbidity following such exposures.[6] Closer to home, data from Oregon's Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE) showed an increase in emergency department visits for asthma-like symptoms in areas affected by the smoke plume from the 2017 Eagle Creek fire (see graph, *verso*.) Further, wildfires typically occur during warmer temperatures. Since both temperature and air pollution affect cardiovascular and respiratory disease adversely, the co-exposure to heat and wildfire smoke could add insult to injury for those living with these diseases.[7]

Long-term exposure to $PM_{2.5}$ might be even worse. The air we breathe contains fine particles from many sources. Some of them, like vehicle exhaust, are around all the time, not just during wildfires. An analysis of $PM_{2.5}$ and vital statistics data from several U.S. metropolitan areas found that each 10 µg/m^3 increase in ambient $PM_{2.5}$ concentration was associated with an increase in the hazard ratio for death by 3–15% depending on the cause; the ratio was particularly elevated for ischemic heart disease.[8]

Lest we start sounding *too* gloomy, take heart: there are steps that you and your patients can take to mitigate risk from exposure to fine particles,

Figure: Emergency department visits for asthma-like symptoms and $PM_{2.5}$ maximum daily concentrations in several Oregon counties* before and during the Eagle Creek Fire, 2017



* Multnomah, Washington, Clackamas, Yamhill, Wasco, Hood River, Columbia counties

whether they be from wildfires or other sources.

WHO'S AT RISK?

Both $PM_{2.5}$ and $PM_{10-2.5}$ can cause problems for people with underlying lung disease, including COPD, asthma and allergies, leading to exacerbations, and difficulty breathing. These particles can also be an issue for children. Since kids have smaller airways, and Poiseuille* tells us that the flow through a tube falls off as the 4th power of the radius, it doesn't take much inflammation, swelling, and constriction in a child's airways to compromise air exchange. That, in addition to the larger amounts of air they breathe per unit body weight, puts children at higher risk of acute respiratory problems from wildfire smoke exposure.

For people with underlying heart disease (whether or not it has been diagnosed), $PM_{2.5}$ is the biggest concern. It increases the risk for both arrhythmia and acute ischemic events. Those with known lung disease, coronary artery disease, the elderly and others who might be at increased risk should avoid exposure to smoke and other sources of fine particles.

WHAT CAN YOU DO ABOUT IT?

Those not in the sensitive groups mentioned above will, no doubt, experience "nuisance" symptoms from wildfire exposure, but are at low risk for acute adverse health effects. That said, it's worth recommending that everyone avoid strenuous activity and prolonged time outside during heavy smoke.

Clinicians can work with their patients to develop respiratory and cardiovascular disease management plans to ensure that patients have easy access to necessary medicines and information about special precautions to take during smoky times.

The Air Quality Index (AQI), a system for rating the level of particles and other pollutants can help your patients make informed decisions about smoke exposure. Readings for many communities in Oregon are available on the Department of Environmental Quality website: https://oraqi.deq.state.or.us/home/map

When the AQI exceeds 100 (Unhealthy for Sensitive Groups), patients in these groups should consider staying inside until the poor air quality improves. Because fine particles can infiltrate even the most airtight of homes given long enough exposure, when poor air quality is expected to persist for several days, people in sensitive groups might think about leaving the area if they have no dependable cleaner air refuge.

Note: Wearing a mask may make people feel safe, but most masks do little to prevent inhalation of $PM_{2.5}$. "N95" or "P100" respirators may be of some benefit, but need to be carefully fitted to be effective.

WHAT ABOUT AIR FILTERS?

This brings to mind a simple intervention: helping your patients in sensitive groups secure a high-efficiency particle air (HEPA) filter. As noted, $PM_{2.5}$ from any source increases the risk of acute health effects in young children and those with heart and lung disease. If they have a HEPA filter, they can set up a cleaner air refuge at home, decreasing their exposure to smoke, as well as other sources of fine particles, and decreasing their health risk. HEPA air cleaners can reduce indoor air particle concentrations by approximately 60–90%.[9] If the area experiences heat waves, an air conditioner or other cooling mechanism is recommended as well.

*19th Century French physicist and physiologist

FOR MORE INFORMATION

- Oregon Health Authority www.oregon.gov/oha/PH/PREPAREDNESS/PREPARE/Documents/SmokeGuidanceforClinicians.pdf
- CDC. Wildfire smoke. www.cdc.gov/disasters/wildfires/smoke.html
- CDC. Protect yourself from wildfire smoke. www.cdc.gov/features/wildfires/index.html
- Environmental Protection Agency. Wildfire smoke factsheet: Protect your lungs from wildfire smoke or ash. https://www3.epa.gov/airnow/smoke_fires/respiratory-protection-508.pdf

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