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Wildfires: Implications for nurses

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Abstract: Wildfire smoke can travel hundreds of miles from its source, resulting in poor air quality. Exposure to poor air quality has been associated with health risks. Nurses should be knowledgeable about such risks to provide appropriate care and education in affected communities.

Keywords: air pollution, lungs, respiratory, smoke, wildfire

Wildfire activity has increased in the western US in recent years. California specifically has had a significant amount of fire-related damage.[1] Eight out of 10 of California's largest fires have all occurred within the last 5 years.

Between 1970 and 1980, fires were responsible for burning 3% of California's land; between 2010 and 2020, fires were responsible for burning 11% of California's land. The August Complex fire in 2020 and the Dixie Fire in 2021 were especially notable due to their size. These fires burned for months and damaged about 1 million acres of land each.[2]

Smoke from a wildfire can travel hundreds of miles from its source. Poor air quality due to smoke has been associated with short- and long-term health implications such as mental health disturbance, asthma exacerbation, and increased risk for cardiovascular disease.[3] Studies show an increase in ED visits, hospitalizations, and morbidity associated with exposure to wildfire smoke inhalation.[4,5]

California wildfires have been getting larger and causing more damage than in previous years.[6,7] Approximately 85% of wildfires are caused by some type of human activity such as campfires, burning cigarette butts, elaborate gender reveal parties, arson, and malfunction of various types of equipment.[8-10]

Nurses must be knowledgeable about potential short- and long-term health implications associated with wildfires so they can educate and provide care for patients in regions where wildfires are endemic.

Severity of California fires

California's climate places this state at risk for increased fire severity. It is very dry, and the only moisture comes in the fall and winter months. The summers continue to get hotter, and there have been decreased rainfall and periods of drought that further contribute to a low-moisture climate.[11]

The southern part of the state is subject to the powerful Santa Ana winds that cause fires to spread three times faster than they normally would. These fires tend to occur closer to urban areas and are related to approximately 80% of the economic damage caused each year.[12,13]

Ironically, the act of fire suppression also increases the region's vulnerability. Putting out fires often leaves behind the dry vegetation that would have been consumed, thus increasing the future risk of a large fire.[13]

A large population also increases fire risk. Urban areas have more power lines that are especially risky in areas with dry vegetation. People are moving into forested areas of California, further increasing the risk of fires started by human activity.[13,14]

Fire season

The term "fire season" describes a predictable pattern of periods during which there exists a greater fire risk in a particular region. California has two fire seasons. June through September are warm and dry months and comprise the "traditional Western fire season." The Santa Ana winds occur from the end of October through the early part of April, creating the second fire season. May is the only month outside of the two fire seasons.[15]

Smoke composition

Smoke from a wildfire can travel and pollute air up to hundreds of miles from its source. This smoke-polluted air is made up of volatile compounds such as nitrogen dioxide, sulfur dioxide, carbon dioxide, carbon monoxide, and ozone, as well as particulate matter (PM) made up of solid particles and liquid droplets. Fine PM is equal to or smaller than 2.5 micrometers ($PM_{2.5}$)–small enough to be inhaled into the lungs and potentially enter the bloodstream.[16]

Wildfire pollution is more damaging to health than other types of environmental pollution, which is already associated with respiratory and cardiovascular disease.[16,17] There are two specific reasons. First, there is a larger concentration of $PM_{2.5}$ in smoke than in general environmental pollution. Second, $PM_{2.5}$ from wildfire smoke remains in the air for longer than that from general pollution.[4,18]

Understanding air quality

Wildfires result in air pollution and poor air quality. Air quality is measured using a scale called the Air Quality Index (AQI) developed by the Environmental Protection Agency. The AQI uses a color-coded numeric system to communicate air quality. It also identifies the populations that will be most affected by the current air quality and offers recommendations to reduce their risk.[3] A higher AQI is correlated with greater air pollution. An AQI of less than 100 is typically considered satisfactory for day-to-day activities; an AQI over 100 is considered a health risk for vulnerable populations. As the AQI level increases, it becomes a health risk for all populations.[21] Several agencies such as AirNow and Purple Air regularly provide a public report of AQI (see *Air Quality Index*). Nurses should be familiar with the various sources that report AQI and understand how to interpret this information so they can anticipate community needs.

Pathophysiologic implications

Within wildfire smoke, there are commonly two types of PM: $PM_{2.5}$ and PM_{10}. While both are harmful, PM that is 10 micrometers in diameter may irritate the eyes, nose, throat, and skin, but generally does not reach the lungs. The alveoli are responsible for clearing harmful substances before gas exchange. The smaller, $PM_{2.5}$, can evade the alveolar clearing mechanism and create long-term damage to the lung tissue. $PM_{2.5}$ triggers a similar immune response as seen with pulmonary infection but the immune system is unable to combat it in the same way. This ultimately leads to airway epithelium damage. This entire process produces inflammation that manifests most commonly as causing or worsening an obstructive pathology due to tissue remodeling in the alveolar space.[19] Tissue remodeling, or airway remodeling, is the process by which the body attempts to repair damaged lung tissue through structural changes but that ultimately leads to the loss of lung tissue integrity and compromised respiratory function.[20]

Clinical manifestations

Health implications associated with wildfires are vast and may be both psychological and physical, short- or long-term. Smoke's ability to travel hundreds of miles means that large populations of people can be impacted by the effects of a single fire. Exposure to wildfire smoke may result in symptoms in the upper and lower respiratory system, cardiovascular system, and dermatologic system. While some symptoms improve along with the air quality, long-term psychological and physical implications may persist beyond the lifespan of the fire.[22]

Common acute signs and symptoms associated with wildfires and exposure to reduced air quality include rhinitis; watery, itchy eyes; nonproductive cough; throat irritation; and skin irritation. These signs and symptoms are primarily caused by large particles and volatile gases in the smoke.[3] These signs and symptoms may occur in all populations regardless of age and health history, though some populations are considered at higher risk. For example, people with a history of respiratory disorders are considered a vulnerable population.[23] Those

Air Quality Index

AQI Category and Color	Index Value	Description of Air Quality
Good: Green	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Moderate: Yellow	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups: Orange	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Unhealthy: Red	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy: Purple	201 to 301	Health alert: The risk of health effects is increased for everyone.
Hazardous: Maroon	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

Source: United States Environmental Protection Agency[3]

with a history of asthma or chronic obstructive pulmonary disease (COPD) may experience an exacerbation of respiratory symptoms such as cough, wheezing, shortness of breath, chest tightness, fatigue, headache, tachycardia, and hypertension.[5]

These signs and symptoms may occur in healthy individuals without a history of respiratory disorders as well, but likely at an AQI greater than 150.[24] The inflammatory response is triggered by prolonged exposure. The duration and severity of signs and symptoms depend on the person, their underlying health history, and the type and extent of PM to which they were exposed. Studies have shown that the effects of breathing this form of polluted air can last for years after exposure.[25]

The inflammatory process can lead to increased clotting factors and increased risk for thrombosis, myocardial infarction, and stroke. Additionally, the autonomic nervous system can cause vascular compromise and elevated heart rate and BP.[26]

People living in areas where wildfires often occur, such as California, may experience behavioral health (BH) changes during and after the fires. Those with preexisting BH disorders may experience health decline during wildfires. Healthy individuals may experience changes in their daily routines, physical activity, outdoor recreation time, and occupational circumstances. Children are affected by disruptions to school, outside play, and sports participation. Adults must also contend with the possibility of evacuation and alterations to home life. The threat to their safety and the safety of their loved ones can trigger significant depression and anxiety.[27]

Some patients may not be victims themselves, but they may develop anxiety and depression from watching their community suffer. Going through these distressful experiences at the same time has been called "community-wide trauma."[28] Patients may present with anxiety attacks, panic, and worsening of already present BH disorders.[28]

Those who are directly affected by the fire may also experience financial burdens. Some may be displaced from their homes and need to find alternate housing; others living close to fires may lose their homes altogether.

Those who do not live in an area that is at risk for burning are not free of financial stress stemming from wildfires. If schools are closed, parents must cope with missing work to watch their children. Others may not be able to go to work due to the hazardous conditions and poor air quality. This is especially true for those who work outdoors.

The social and economic impact of fires may lead to depression, anxiety, and sleep problems that linger long after the fire is extinguished. Victims of fire may experience posttraumatic stress disorder.[28] Nurses should be prepared to assess the patient for signs and symptoms of depression and anxiety and make appropriate referrals to support mental health.

Vulnerable populations

Certain populations have greater health risks when presented with reduced air quality due to wildfire smoke. Vulnerable populations include children, older adults, pregnant women, and those with preexisting conditions such as diabetes mellitus, cardiovascular disease, COPD, and asthma.[10] Children typically spend a great deal of time outdoors and engage in physical activity, exposing them to a greater risk of inhaling polluted air.[3,23]

Pregnant women have a higher respiratory rate and blood volume than nonpregnant women. This increases a pregnant woman's risk of exposure in general. Studies have also shown that exposure to wildfire smoke may also harm a developing fetus.[3,29] Low birth weight, impaired lung development, alterations in immunity, and increased infant mortality are some of the complications

associated with exposure to poor air quality during pregnancy.[30]

Older adults are considered a vulnerable population because of the increased likelihood of preexisting comorbidities. Air pollution, in general, has been associated with respiratory and cardiovascular events, and therefore, older adults are at increased risk during wildfires.[3,23]

The need for health services

Healthcare systems in areas prone to wildfires need more resources. Studies show increased utilization of healthcare systems during times of fire.[4,5] Fortunately, in most communities, most of the population will have mild signs and symptoms or an asymptomatic decrease in their lung function. However, others experience a substantial decline in their health such as experiencing respiratory distress or a cardiac event that requires emergency medical services and possibly hospitalization.

Most of the population falls somewhere in between, requiring additional medical care due to experiencing signs and symptoms related to smoke exposure, such as cough, asthma exacerbations, itching and burning eyes, nasal congestion, tachycardia, dizziness, and BH concerns. Some patients may also require additional healthcare due to having to evacuate without their medications and medical supplies.[5]

The role of nurses

Nurses play an essential role in managing the impact of disasters within their communities.[31,32] Providing patient care during a wildfire is unique to the provision of care because nurses are likely experiencing personal effects from the fire. Nurses need to be ready to respond to community needs without forgoing self-care. Various models such as the Disaster Management Cycle have been used to guide nurses in their role in wildfires.[32,33]

Nurses living in at-risk areas should devote time to learning about the health implications of wildfires. This includes improving knowledge of vulnerable populations, air quality, and patient outcomes. They may also identify various healthcare facilities in the region in case of the need for evacuation or diversion. Assess what additional supplies may be needed during wildfire seasons such as nebulizers and oxygen supplementation. Nurse leaders may benefit by reviewing policies and procedures about wildfires and advocating for change if needed.

Nurses should educate patients on how to assess their risk from wildfires and how they might mitigate such risk. For example, spending limited time outdoors when air quality is reduced. Community members should be reminded to include any required prescription medications in a "to-go" bag in case of the need for evacuation.[21,32]

During a wildfire, nurses can recognize immediate public health needs in a population-based triage and intervene in the changing health of patients. Being aware of evacuation center locations, aiding patients in accessing medication and medical supply replacements, and directing patients to resources when they have had to evacuate their homes are essential tasks for nurses.[31,32]

Once the fire is over and air quality has improved, nurses should aid the community in returning to optimal physical and mental health. This may require a great deal of time, as the damage done from a fire can have a significant and lasting impact.[32]

Nurses can help patients navigate the trauma from wildfires. Specifically, a nurse should be prepared to assess for signs and symptoms of depression and anxiety.[28,34]

Finally, nurses must be able to guide the patient through their healthcare journey despite potential financial changes the patient may encounter.[32]

Conclusion

California's wildfires are a recurring phenomenon that have detrimental implications for individuals and communities. Evidence shows that increasing severity of environmental factors such as climate change, winds, and drought will further contribute to the number and severity of Californian fires. These wildfires and the reduction in air quality negatively impact the health of community members and thus increase the use of health services.[3-5] Nurses serve as healthcare leaders in these affected regions. Nurses who are knowledgeable about the health implications of wildfires are better positioned to serve these vulnerable communities and minimize the negative health effects of wildfires. ■

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The authors and planners have disclosed no potential conflicts of interest, financial or otherwise.

DOI-10.1097/01.NURSE.0000839804.04081.c0