Where There’s Wildfire, There’s Smoke: An Epidemiological Perspective

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Outline

• Wildfire
• Climate change
• What’s in wildfire smoke
• Community health effects
• Wildland firefighter health issues
Southern CA Wildfires – Dec. 2017
Carr, Mendocino Complex, and Camp Fires - 2018
2017 and 2018 were Bad Wildfire Years - Why?

- 5 years of drought 2011-2016; many dead trees
- *El Nino* winter of 2017 brought lots of rain, ending the drought
- Increased growth of vegetation in spring
- Normally dry and very hot summer weather generating lots of fuel
- Lack of rain in fall
Climate Change and Increase in Wildfires

% CHANGE IN EXPECTED MINIMUM NUMBER OF LARGE FIRES PER YEAR

- LOWER WARMING RANGE
- MEDIUM WARMING RANGE

2035-2064

2070-2099

Source of data: Westerling and Bryant, "Climate change and wildfire in and around California: Fire modeling and loss modeling" (2006), www.climatechange.ca.gov
Emissions from Wildfires

Primary air pollutants
– Particulate Matter (PM)
– Carbon monoxide (CO)
– Nitrogen dioxide (NO$_2$)
– Polycyclic aromatic hydrocarbons (PAHs)
– Volatile organic compounds (VOCs)

Secondary air pollutants
– Particulate Matter (PM)
– Ozone
Coffey Park neighborhood burning
When Buildings and Vehicles Burn

• Structural fire smoke contains other toxic air contaminants, including
  – Hydrogen cyanide (HCN), hydrochloride (HCl), phosgene, metals
  – Toluene, styrene, dioxins

• The Sonoma-Napa, Thomas, and Camp fires caused many buildings and motor vehicles to burn
  – Local residents exposed to more than wood smoke

• The plumes that travelled to the San Francisco Bay Area and Greater Los Angeles were almost entirely wood/biomass smoke
Air-Quality Impacts and Intake Fraction of PM$_{2.5}$ during the 2013 Rim Megafire

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Daily Mass Intake µg PM$_{2.5}$ per person

- 0 - 486
- 487 - 1459
- 1460 - 2919
- 2920 - 18141

Higher (RED) exposures levels are 500 times the 24-hour National Ambient Air Quality Standard

Reference:
EPA 24 hr PM$_{2.5}$ standard = 35µg/m$^3$
Camp Fire – Nov. 9, 2018
Poor Air Quality in Bay Area

- Nov. 14, 2018 – PM$_{2.5}$ goes over 200 µg/m$^3$ that Thurs. evening and is projected to stay high for days
  - UC Berkeley cancels classes, but does not close campus
  - UC Berkeley postpones the “Big Game” with Stanford scheduled for Sat. Nov. 16
Even Poorer Air Quality Closer to Fire

Nov. 15, 2018 – PM$_{2.5}$ goes up to 250 µg/m$^3$ in Sacramento and over 300 µg/m$^3$ in Yuba City
Acute health impacts of short-term community wildfire smoke exposures
Clear evidence of an association between wildfire smoke and respiratory health

- Asthma exacerbations significantly associated with higher wildfire smoke in nearly every study.
- Exacerbations of chronic obstructive pulmonary disease (COPD) significantly associated with higher wildfire smoke in most studies.
- Growing evidence of a link between wildfire smoke and respiratory infections (pneumonia, bronchitis).
Cardiovascular effects
Victoria, Australia - Dec 1, 2006 - Jan 31, 2007

Haikerwal et al. 2015 J Am Heart Assoc
**Wildfire-PM\textsubscript{2.5} Increases Heart Attack & Stroke**

- **Wildfire-PM\textsubscript{2.5} associated with heart attacks and strokes for all adults, particularly for those over 65 years old**

- **Increase in risk the day after exposure:**
  - All cardiovascular, 12%
  - Heart attack, 42%
  - Heart failure, 16%
  - Stroke, 22%
  - All respiratory causes, 18%
  - Abnormal heart rhythm, 24% (on the same day as exposure)

*Slide credit: Wayne Cascio*

*Wettstein Z, Hoshiko S, Cascio WE, Rappold AG et al. JAHA April 11, 2018*
Wettstein Z, Hoshiko S, Cascio WE, Rappold AG et al.
JAHA April 11, 2018
Other Health Outcomes

• Adverse birth outcomes
• Mental health
• Based on the PM$_{2.5}$ literature
  – Metabolic outcomes
  – Cognitive decline
  – Child neurodevelopment
  – Health of pregnant mothers
Wildland Firefighters

• Crews
  – Hand
  – Smokejumpers
  – Engine/Dozer

• Work Conditions
  – Long shifts
  – Rough terrain
  – Elevations
  – Remote locations
Wildland Firefighter Health Effects

• Cross-shift changes in lung function, urinary biomarkers of exposure, and blood biomarkers of inflammation

• Pre-post season changes in lung function, airway responsiveness, and airway inflammation

• Do the fire season-associated changes persist?
Exposures to 17 Polycyclic Aromatic Hydrocarbons (PAHs) were measured in 21 wildland firefighters suppressing two wildfires and 4 working on prescribed burns.

Naphthalene, retene, and phenanthrene were consistently the highest measured PAHs.

PAH concentrations were higher at wildland fires than at prescribed burns.
Estimated the daily dose of wildfire smoke PM$_{2.5}$

The daily dose for firefighters working 98 days per year of PM$_{2.5}$ ranged from 0.30 mg to 1.49 mg

For career durations (5–25 years), wildland firefighters had an estimated increased risk of lung cancer (8 percent to 43 percent) and cardio vascular disease (CVD) (16 percent to 30 percent) mortality
Research Needs

- Longitudinal Study
- Exposure Assessment
- Chronic Health Outcomes
  - Lung and heart disease
  - Lung cancer
- Personal Protective Equipment for Wildland Firefighters

https://www.flickr.com/photos/usdagov/9493260225
Summary

• The duration of the wildfire season is longer and catastrophic wildfires are increasing in frequency due to climate change
• Acute respiratory effects are well documented, but new studies suggest acute cardiovascular effects as well
• Long-term effects in wildland firefighters need further study
Thank you