Forest Fire Smoke and Respiratory Health in British Columbia

BC Lung Association Air Quality Webinar

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BC is forested and flammable...

Land cover types in B.C. as percent of total land area

- Forest: 70%
- Alpine: 7%
- Wetlands: 4%
- Glaciers: 3%
- Freshwater: 2%
- Human Dominated: 1%
- Grasslands: 13%

* Areas mapped as: urban, agriculture, recreation (e.g., golf courses) or mining.

Climate change is making things worse...

In the past 50 years, BC annual mean temperature has increased by 1.5°C.

Photo from: cbc.ca
Warmer winters = More bugs = Dead trees

https://www.for.gov.bc.ca/hfp/mountain_pine_beetle/maps.htm
Ample fuels to burn + Hotter summers = More intense fire seasons

Annual Area Burned (hectare) in BC

Mountain pine beetle outbreak started
We have an early start this year...
Forest fire smoke is complex, but PM is the most studied.
Forest fire smoke is a major contributor of extreme PM exposure.
How can we measure population exposure?

http://cleantechnica.com/2012/12/24/monitoring-air-quality-from-your-smart-phone/
Air quality monitors
- High time resolution
- But we don’t have them everywhere
Satellite imaging

- Large coverage
- But only a bird’s eye view
We developed an empirical model to integrate both...

The BCCDC forest fire smoke exposure model
Smoke forecasts can provide spatially resolved surface PM predictions.
Population health impacts can be described by a pyramid...
Salbutamol dispensations:
5% increase per 10 ug/m³ higher in PM$_{2.5}$

Cariboo-Chilcotin LHA

- Dispensations
- PM$_{2.5}$

Elliot et al. Environmental Health 2013
Physician visits:
Asthma-specific: 6% increase
All respiratory: 2% increase

Henderson et al. EHP 2011:119(9)
Hospital admissions: All respiratory: 5% increase

<table>
<thead>
<tr>
<th>Outcome</th>
<th>ICD-9</th>
<th>TEOM Per 10 µg/m³</th>
<th>TEOM Per 30 µg/m³</th>
<th>CALPUFF (per 60 µg/m³)</th>
<th>SMOKE (1 vs. 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physician visits</td>
<td>All respiratory</td>
<td>1.02 (1.01–1.03)</td>
<td>1.05 (1.03–1.06)</td>
<td>1.01 (0.99–1.03)</td>
<td>1.08 (0.99–1.18)</td>
</tr>
<tr>
<td>Asthma</td>
<td>All respiratory</td>
<td>1.06 (1.03–1.08)</td>
<td>1.16 (1.09–1.23)</td>
<td>1.04 (1.02–1.06)</td>
<td>1.21 (1.00–1.47)</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>All respiratory</td>
<td>1.00 (0.99–1.01)</td>
<td>1.01 (0.99–1.02)</td>
<td>1.00 (0.98–1.02)</td>
<td>0.98 (0.92–1.05)</td>
</tr>
<tr>
<td>Hospital admissions</td>
<td>All respiratory</td>
<td>1.05 (1.00–1.10)</td>
<td>1.15 (1.00–1.29)</td>
<td>1.11 (1.04–1.18)</td>
<td>1.60 (0.90–2.81)</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>All respiratory</td>
<td>1.00 (0.96–1.05)</td>
<td>1.00 (0.92–1.11)</td>
<td>0.80 (0.60–1.14)</td>
<td>1.12 (0.89–1.66)</td>
</tr>
</tbody>
</table>

All models are adjusted for same-day mean temperature, day of week, and week of study.
Results for mortality in previous studies were inconsistent...

Need the most power to detect

Need to include as big of a population as we can!
In BC, **38%** of all deaths occurred in areas that **DO NOT** have a monitor within 10km.
Our model can help! It covers all populated areas in BC.

The BCCDC forest fire smoke exposure model
We need to know a lot more... What about exposure for a few hours?

Two scenarios for a daily average exposure of 25μg/m³

Should we worry about the peak?
What we can do as

- Public health agencies
- Susceptible individuals
Before fire season starts, public health agencies should be ready with:

1. Surveillance systems
2. Evidence-based messaging
3. Concrete action plans for different interventions

BC Asthma Monitoring System (BCAMS)

- Weekly report
- Surveillance on
  - Health
    - Medication refill
    - Physician visits
  - Exposure
    - Four measures
Clear advice: who should do what?

Asthma Action Plan

**IMPORTANT INFO**

- **Name:**
- **Date:**
- **Doctor name:**
- **Doctor phone:**
- **Emergency contact:**
- **Emergency phone:**

**EXERCISE-INDUCED FLARE-UP**

- **Instructions for an exercise-induced asthma flare-up**
- **Medicine:**
- **How much:**
- **When:**
- **Additional instructions:**

**TRIGGERS:**

- pollen
- mold
- dust mites
- animals
- smoke
- food
- exercise
- cold/flu
- weather
- air pollution
- other
Properly sized HEPA air cleaners can greatly reduce indoor PM during smoke events.

- HEPA filter
  \[ F_{\text{inf}} = 0.36 \pm 0.11 \]

+ HEPA filter
  \[ F_{\text{inf}} = 0.17 \pm 0.06 \]
Cancelling outdoor events
Providing community clean air shelters
Augmenting air filtration in institutions
Evacuating
Before fire season starts, susceptible individuals should be ready with:

1. Ample rescue medication
2. A plan to minimize exposure
3. Emergency backup plan if 1 and 2 are not enough
Who is susceptible?

- Populations with pre-existing respiratory disease
- Populations with pre-existing cardiovascular disease
- Adults over 65 years of age
- Children
- Unborn children
There will be more forest fires and more smoke.

Many tools to help evaluate and forecast exposure.

Exposure can trigger pre-existing respiratory diseases.

A lot more knowledge of health effects and intervention effectiveness is needed.

Public health agencies and susceptible individuals should have a plan in response to smoke events.