Wood Burning and Health: What Should Clinicians Know?

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Air pollution and health

- Air pollution (individual) risk is small...but large exposed population = large population risk
  - Smoking: Larger risk, smaller exposed population
- On days with worse air quality, more people die*
- In more polluted cities, people die earlier than in less polluted cities...
- ...and, in the most polluted areas of cities, there is an increased risk of dying


*out-of-hospital, >65 yrs
“...the overall evidence is consistent with a causal relationship between PM2.5 exposure and cardiovascular morbidity and mortality.”
103,000 deaths/yr PM$_{2.5}$ (7305 deaths/yr ozone)
Among top risk factors (#8 deaths, #10 DALYs)
Wood biomass fuels in context

• Inexpensive, secure fuel
  – Increasing/fluctuating costs & taxes for fossil fuels
  – Energy independence

• Promoted by public policies as a renewable, GHG-neutral fuel

• Relatively unregulated source
  • federal regulations minimal
  • state scrutiny varies

• Impact on winter air quality coinciding with stagnation

• Exposure proximity, high “intake fraction”

• Health impacts largely absent from policy debate

• Solutions exist!
The Fog of Austerity: This Smoke Cloud Is the Ultimate Symbol of Greece's Depression

“Utility bills are now so expensive for Greek families that some have taken to burning wood to stay warm. The result is an eerie fog of smoke looming above the city.”
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Primary PM Emissions

Pittsburgh Regional Environmental Threats Analysis Report (PRETA) - PM, 2012

99% biomass combustion
Industrial Biomass Sources in PA


Slide courtesy, Pete DeCarlo, Drexel Univ.
Woodsmoke air quality impact

- Rochester, NY – Winter evenings
  - 30% of winter PM
- Seattle
  - ~30% heating season PM$_{2.5}$
- Fairbanks
  - 60 - 80% winter PM$_{2.5}$
- Atlanta
  - 11% annual PM$_{2.5}$
- Portland
  - 27% annual PM$_{2.5}$
- Las Vegas
  - 11 – 21% annual PM$_{2.5}$

Winter (November-April) mean: 1.6 μg/m$^3$

Cold winter night (20% of year) mean: 8.5 μg/m$^3$
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Biomass smoke and health: evidence

- Constituents/Composition (PM$_{2.5}$, aldehydes, PAHs)
- Toxicology
- High concentration, chronic exposures – developing countries
- High concentration acute/sub-chronic exposures – wildland firefighters
- Firesmoke, agricultural burning
- Controlled human exposures
- Residential woodsmoke epidemiology

- Very little direct research on health impacts of Industrial / Commercial / Institutional scale combustion
Combustion conditions, composition & toxicity

Wood smoke soot
- BC

Wood smoke organic particles (low-temp combustion)
- Org

"Good" wood pellet combustion PM (alkali salt particles)
- Chl
- NH₄
- SO₄
- NO₃

Pellet burner
- BC
- Chl
- NH₄
- SO₄
- NO₃
- Org

Log wood burner
- BC

More Toxic
Less Toxic

M. F. Heringa; P. F. DeCarlo; R. Chirico; A. Lauber; A. Doberer; J. Good; T. Nussbaumer; A. Keller; H. Burtscher; A. Richard; B. Miljevic; A. S. H. Prevot; U. Baltensperger; Environ. Sci. Technol. 2012, 46, 11418-11425. DOI: 10.1021/es301654w Copyright © 2012 American Chemical Society
Controlled human exposure studies

• Subjects exposed to realistic (high) concentrations (~250 μg/m³) of woodsmoke for 4 hrs
  – Increases in measures of inflammation, oxidative stress post-exposure compared to clean air

• Pellet stove incomplete combustion
  - No inflammation
  - Early adaptive protective response


Biomass smoke epidemiology

” .....generally consistent relationship between exposure and increased respiratory symptoms, increased risk of respiratory illness, including hospital admissions and emergency room visits, and decreased lung function. Several studies suggest that asthmatics are a particularly susceptible subpopulation ....”
Woodsmoke & multiple health measures

- 15% increase in SGA birth
- 32% increase in otitis media
- 8% increase in bronchiolitis
- 15% increase in COPD hospitalization
- No associations with:
  - pre-term birth
  - asthma incidence
  - cardiovascular, COPD mortality

• ~30% reduction in winter PM$_{2.5}$
• ↓ in childhood wheeze, itchy eyes, sore throat, cold, bronchitis, influenza, throat infections
• School absence associations inconsistent

• ~39% reduction in winter PM$_{10}$
• ↓ winter cardiovascular (-19.6%) and respiratory (-27.9%) mortality
• Similar decreases not observed in control community

Policy implications

• Woodsmoke is an important source of air pollution in many rural and urban areas
• Evidence for health impacts of magnitude similar to other widely recognized risk factors
  – e.g Eliminating woodsmoke: 10% reduction in otitis media incidence:
    • Maternal smoking during pregnancy or secondhand smoke exposure: 2% reduction
    • Pneumococcal conjugate vaccine: ~ 6-7% reduction
• Suggests cost-effectiveness of exposure reduction
• Advanced technology combustion
  – Derive max energy
  – Lower mass emissions
  – Lower toxicity

E. MacIntyre, PhD Thesis, UBC, 2010
What can clinicians do?

- Consider woodsmoke as a potential risk factor for pregnant women and patients with recurring respiratory infections, otitis media, asthma, COPD
- HEPA filter air cleaners
- Community stove exchanges
- Advocacy for advanced combustion and emission controls in local decision-making regarding institutional-scale boilers
Thank you!

Questions?

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