Respiratory Illness & Indoor Air Quality

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Respiratory Illness in Alaska Native Children

Alaska Native/American Indian children bear a high burden of respiratory disease
  - (1.6 fold higher than general US child rate)

Lower respiratory tract infection associated hospitalizations for Alaska Native children:
  - 3.7 times higher than that of general US children rate (infants)

Pneumonia hospitalization rate in rural western Alaska Native infants
  - 10 fold higher than general US infant rate

Lower Respiratory Tract Infection Hospitalization Rates; general US vs. American Indian/Alaska Native vs. Alaska Native, 2009-2011

LRTI hospitalizations

Alaska Native/American Indian infants
- 1.6 fold higher than general US child rate

Alaska Native infants:
- 3.7 times higher than that of general US children rate (infants)
  - (136.4 vs. 37.1 per 1000/year)

**Alaska Native**
- 3.7-fold higher than general U.S.
- 1.6-fold higher than general US child rate

**General U.S.**
- 1.6-fold higher than general US child rate

**American Indian/Alaska Native**
- 3.7-times higher than general US children rate (infants)
- (136.4 vs. 37.1 per 1000/year)

**LRTI – lower respiratory tract infection**

*Foote E et al., 2015, Int J Circumpolar Hlth*
Pneumonia hospitalizations, Alaska Native infants, by region, 2009-2011

Northern and western rural regions – 10-fold higher than U.S.

Anchorage, urban and Southeast regions – Similar to the U.S.

Foote et al., Alaska Native Research Conference, 2014
Pneumonia-associated hospitalizations in AI/AN and US infants, 1998-2011

Pneumonia hospitalization rate is decreasing with improvements and vaccines!

Long Term Effects of Childhood Pneumonia

A. Pneumonia can cause damage to airways

B. This leads to a chronic wet cough

C. Some get permanent lung damage

This can lead to adult COPD
Bronchiectasis: Long-term Sequelae of Pneumonia

- Indigenous children have high rates of non-CF bronchiectasis
- Early/Recurrent pneumonia in childhood is the major risk factor
- Bronchiectasis can lead to morbidity/mortality by the 3rd decade

Asthma & Cough in Alaska Kids

• American Indian/Alaska Native children have asthma prevalence similar to other U.S. children.

• Alaska Native children have a high prevalence of asthma or asthma-like symptoms or chronic cough

Lewis et al – Interviewed 377 middle school children in Southwest Alaska

- 40% reported a chronic respiratory condition
  - 7.4% - physician-diagnosed asthma,
  - 11.4% - asthma-like symptoms without asthma diagnosis,
  - 21.5% chronic productive cough without asthma diagnosis,

Indoor Environment Matters!

- Household crowding
- Tobacco Smoke
- Wood-burning
- Chemicals – fuel, fixing engines
- No in-home running water
- Poor ventilation

Rural Alaska houses are small, crowded, and often use woodstoves.
Risk Factors for LRTI and RSV Hospitalizations, Alaska Native children

- Medical conditions (premie, heart disease, chronic lung disease)
- Absence of breastfeeding
- Household crowding
- No piped water; <2 rooms with sinks
- Woodstove in the house
- Vomiting after feeding
- Low income

Household Crowding in the U.S.: 2000 Census Data

Hospitalization rate among infants by percentage of rural Alaska village homes with water service, 1999–2004

Indoor Air Pollution: Navajo and Alaska Native Children

• Any wood burning stove in the home increased odds of childhood lower respiratory tract infection (LRTI) by 4.9 times in Navajo children

• Household particulate matter concentration >65 μg/m³ resulted in an increase of odds of LRTI by 7 times in Navajo children

• Risk Factors for LRTI hospitalizations in rural Alaska included household crowding and woodstove use.

What Works? Evidence-based Interventions

- **Wood-stoves**: HEPA filters, change out wood stove, best burn practice

- **Ventilation**: install or fix vents, install range exhausts and bathroom fans, heat recovery ventilators, air exchange

- **Dust and Dust mite**: impermeable pillow/mattress covers, wash bedding, remove carpet, cleaning/vacuuming

- **Pets**: remove pets, keep pets out of bedroom

- **Mold**: address moisture, ventilation, remove carpet

- **Irritants**: HEPA filters, increase ventilation

CDC Task Force Findings and Rationale Statement Interventions for Children and Adolescents with Asthma [http://www.thecommunityguide.org/asthma/rrchildren.html](http://www.thecommunityguide.org/asthma/rrchildren.html)
Last updated: 6/15/2010
The Community Guide: Asthma Control
Centers for Disease Control & Prevention

Systematic review of available studies

HOME BASED MULTI-TRIGGER-MULTI-COMPONENT INTERVENTIONS FOR CHILDREN/ADOLESCENTS WITH ASTHMA

Strong evidence of effectiveness in reducing symptom days, improving quality of life or symptom scores, and in reducing the number of school days missed
Background: Similar study Intervention

Study: Canadian Inuit Children

• Inuit: highest RSV hospitalization rate in the world – small very tight homes.

• Study: Inuit homes randomized to receive Heat Recovery Ventilators or Placebo

• Results in Treatment Group:
  – CO₂ decreased
  – Relative humidity decreased
  – Wheezing decreased 12%
  – Runny nose decreased

Partnering with:
ANTHC Div. Environmental Health & Engineering
ANTHC Community Health and Environment
It started with a call from lung specialist, Dr. Madhani, to Environmental Health Specialist, Troy Ritter.

I think household air problems are making my COPD patients sicker

Woodstoves could be one possible source. We'll look into this.
The Healthy Homes Study

**Partners**
- Alaska Native Tribal Health Consortium (lead)
- Yukon Kuskokwim Health Corporation
- Bristol Bay Area Health Corporation
- Arctic Investigations Program - CDC

**Goal**
- See if home improvements can reduce pollutants and improve health in children with lung disease

**Methods**
- Identify homes of children with lung problems
- Assess homes for indoor air quality
- Simple home renovations (woodstove changeout, vents, range hoods etc.) and education
- Check indoor air quality (PM2.5, VOC, CO2) and lung symptoms before and after

AJ Salkoski, Environmental specialist
Indoor air pollutants: PM2.5

https://www.slideshare.net/faizanmohdiitb/air-pollution-and-smog
Sources of Volatile Organic Compounds (VOCs)

VOCs are emitted by a wide array of household products. Paints, varnishes, and wax all contain organic solvents, as do many cleaning, disinfecting, cosmetic, degreasing and hobby products. Fuels are made up of organic chemicals.

Methods

• Choose YKHC and BBAHC communities

• Eligible homes with child who has chronic lung problems

• Environmental Health and Housing Authority staff assess home:
  – Inadequate ventilation, leaky woodstove, moisture problems
  – Identify contaminants
  – Other factors (e.g., smoking, fuel storage inside home)

• The resident, housing and environmental health personnel decide scope of work

• Air sampling and household education

• Housing personnel complete modifications
New and/or Improved Vents

Ventilation intake plugged with a rag

New ventilation intake
Cooking Stove Exhaust Installed

Cooking stove with no range exhaust

New range exhaust
Woodstove Replacement

Old woodstove

New EPA-certified, low-emission woodstove
Results: Home Assessments and Remediation

• 63 homes were assessed. 60 homes completed interventions

• Remediation in homes included:
  – Ventilation improvements - 59 homes (98%)
  – Woodstove replacement - 28 homes (47%)
  – New oil-fueled furnace - 14 homes (23%)
  – Moisture abatement - 6 homes (10%)
How did study houses compare with other U.S. homes?

<table>
<thead>
<tr>
<th>Housing</th>
<th>Study houses</th>
<th>U.S. houses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean # occupants</td>
<td>7.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Median sq. feet</td>
<td>920</td>
<td>2,465</td>
</tr>
<tr>
<td>% &gt;1 person/room</td>
<td>73%</td>
<td>3%</td>
</tr>
<tr>
<td>% with woodstove primary heat</td>
<td>16%</td>
<td>2%</td>
</tr>
<tr>
<td>% w/ smokers</td>
<td>49%</td>
<td>26%</td>
</tr>
<tr>
<td>% no running water</td>
<td>60%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

U.S. data from 2008-2012 Census, American Community Survey
Results: Indoor Air Pollutants and Symptoms

- High levels of pollutants (VOCs, PM2.5)

were associated with

- Rates of REPORTED cough, wheeze, lung infections in children
## Indoor Air Measures: Study Homes

<table>
<thead>
<tr>
<th>Measure</th>
<th>Cut-off</th>
<th>Cut-off</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM 2.5 (ug/m3)</td>
<td>&gt;25 ug/m3</td>
<td>51% over the cutoff</td>
</tr>
<tr>
<td>CO2 (ppm)</td>
<td>&gt;1000 ppm</td>
<td>70% over the cutoff</td>
</tr>
<tr>
<td>Ave. Rel Humidity (%)</td>
<td>&lt;30%</td>
<td>&lt;30 over half of time (30%)</td>
</tr>
<tr>
<td></td>
<td>&gt;60%</td>
<td>&gt;60 over 1% of time (18%)</td>
</tr>
<tr>
<td>Temperature (ºF)</td>
<td>Average 74, Max 84</td>
<td></td>
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Healthy Homes Study: Baseline findings

• **Indoor Air Quality**
  – High Volatile Organic Compounds (VOCs) and Particulates (PM2.5)

• **Respiratory symptoms in study household children**
  – high rates of cough between colds, hospitalization for lung infections, history of pneumonia, and wheezing.

• **Household factors and child symptoms**
  VOCs  Were related to  Cough between colds
  Primary wood heat  Were related to  Wheeze between colds
  PM2.5  Were related to  Asthma diagnosis
Healthy Homes Study Results

AFTER HOME IMPROVEMENT

• Decreased parent-reported symptoms in children
  ↓ colds or runny nose
  ↓ cough between cold
  ↓ wet cough
  ↓ wheezing with cold
  ↓ need for inhaler of nebulizer

• Decreased parent-reported missed school

• Decreased visits for lung infections in high risk children
Household factors contributing to indoor air pollution

- Household smoking contributed to PM2.5
- Woodstove use contributed to PM2.5, BTEX
- # persons in house contributed to PM2.5, BTEX, VOC, CO₂, Rel Humidity
- No Piped water contributed to BTEX, VOC, CO₂
In Summary:

• Houses in rural Alaska are smaller and more crowded than most U.S. houses.
• Some indoor pollutants like PM2.5 and VOCs occur at high levels in homes.
• Household crowding, smoking, lack of running water and woodstove use contribute to indoor air pollutants.
• Indoor air pollutants contribute to children’s symptoms (cough, wheeze, runny nose)
• Household remediation and education can benefit high risk children
  – decreased respiratory symptoms
  – decreased respiratory visits
  – decreased school absenteeism
Other Interventions to Reduce PM2.5

• HEPA Air Filtration Units (Montana research)
  – Initial community-wide wood stove changeout program resulted in reduced wintertime outdoor PM2.5 and childhood wheeze and respiratory infections.
  – However, team observed variable and uncertain effects on PM2.5 after new wood stoves.
  – In randomized intervention trial of asthmatic children living in wood stove homes, HEPA air filtration units were less costly and more consistent in reducing PM2.5 (~60%) than wood stove changeout (no significant change)
  – Current study is evaluating whether home-based education is as effective and less costly than HEPA filter in reducing indoor PM2.5 and lung infections.

Ward TJ. Results of a residential indoor PM2.5 sampling program before/after a woodstove... Indoor Air 2008;18(5):408-15.
Take Home Points: Best Burn Practices

• Burn only wood, not trash etc.
• Burn dry wood
• Limit opening of woodstove
• Use EPA-certified woodstove
Next Step.....
Environmental Health Hospital Consultation Study

Years: 2016-2019

Organizations: ANTHC, SCF, YKHC, Maniilaq, BBAHC

Objectives: Pilot project to test feasibility of hospital-based ANMC environmental consults

Methods: Environmental health specialists does consult with caregivers of inpatient children hospitalized with respiratory illness

– Provide education on home environment, best burn practices, cleaning, water mitigation etc.
– Mail Indoor Air “Toolkit” – CO monitor, wood moisture tester, cleaning supplies etc.
– Village Housing referrals – to fix woodstoves, improve ventilation, fix furnace etc.

Questions?
1. Is it feasible to provide environmental health consults as a regular hospital service?
2. Do consults change caregiver behaviors. Do houses receive the remediation?
The Air Matters toolkit is comprised of items meant to promote health and safety in the home. The items either measure or control contaminants and encourage behaviors, like burning dry wood and controlling moisture, that will hopefully result in a healthier home environment for all and lower respiratory infections for children living in rural communities.

Includes:
- Chimney thermometer
- Green cleaning kit/surface mold removal kit (Bon Ami cleaner, spray bottle, sponge, scrub brush, squeegee, N95 mask, and a microfiber cloth)
- Hygrometer
- Non-toxic pest trap
- Digital wood moisture meter
- Instant lead test kit
- Radon gas detection kit
- Allergen free pillowcase
- Carbon monoxide detector
- Cue cards (on next slide)
Acknowledgements

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• Yukon Kuskokwim Health Corporation

• Bristol Bay Area Health Corporation

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