Improving Asthma Control Through Home-Based Environmental Assessment

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Regional Asthma Coalitions

• Regional Asthma Coalitions to reduce the burden of asthma in New York State.
• Funded to implement interventions in counties with high rates of asthma-related hospitalizations and emergency department visits.
• Focus services on high risk populations, convene and engage local stakeholders, and apply a population-based, systems change approach that translates the National Asthma Education and Prevention Program, Expert Panel Report-3 Asthma Guideline into practice.
• This initiative aims to increase the quality of life among individuals living with asthma and to decrease the number of asthma-related hospitalizations, emergency department visits, urgent care visits and school or work days lost.

https://www.health.ny.gov/diseases/asthma/coalitions.htm

For questions:
asthma@health.ny.gov

New York State Regional Asthma Coalitions
Asthma Facts 2016

- 24 Million people in the USA
- ER visits: 1.8 Million (2011)
- MD visits: 10.5 Million (2012)
- 70 to 85% treated by primary care physicians.
- Hospital Inpatient: about ½ Million p.a.
- Between 1980 and 2016: jump of more than 1/3
- Asthma related deaths
  - 1979: 2000
  - 1990: 4500
  - 2016: 3651
- Costs: $ +$4.5 billion/year (ERs, Hospital, meds)
- $ +$2 billion/year (Indirect costs/wages)
- Estimated: 40% saving with improved diagnosis, treatment and prevention

### National
### Current Asthma Prevalence (2014)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Number with Current Asthma (in thousands)</th>
<th>Percent with Current Asthma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>26,696</td>
<td>7.7%</td>
</tr>
<tr>
<td>Child (Age &lt;18)</td>
<td>6,892</td>
<td>6.0%</td>
</tr>
<tr>
<td>Adult (Age 18+)</td>
<td>19,804</td>
<td>7.4%</td>
</tr>
<tr>
<td>Age Groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-4 years</td>
<td>445</td>
<td>4.2%</td>
</tr>
<tr>
<td>5-14 years</td>
<td>4,294</td>
<td>10.3%</td>
</tr>
<tr>
<td>15-19 years</td>
<td>1,352</td>
<td>9.1%</td>
</tr>
<tr>
<td>20-24 years</td>
<td>1,590</td>
<td>0.5%</td>
</tr>
<tr>
<td>25-44 years</td>
<td>3,531</td>
<td>7.5%</td>
</tr>
<tr>
<td>45-64 years</td>
<td>8,893</td>
<td>7.2%</td>
</tr>
<tr>
<td>65+ years</td>
<td>3,084</td>
<td>6.9%</td>
</tr>
</tbody>
</table>

### National
### Asthma Mortality (2014)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Number of deaths*</th>
<th>Deaths/100,000 Per Billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2,954</td>
<td>14.5*</td>
</tr>
<tr>
<td>Child (Age &lt;18)</td>
<td>187</td>
<td>2.1*</td>
</tr>
<tr>
<td>Adult (Age 18+)</td>
<td>2,767</td>
<td>14.1*</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White M/F</td>
<td>3,063</td>
<td>8.8</td>
</tr>
<tr>
<td>Black M/F</td>
<td>101</td>
<td>0.5</td>
</tr>
<tr>
<td>Other M/F</td>
<td>180</td>
<td>5.9</td>
</tr>
<tr>
<td>Hispanic M/F</td>
<td>201</td>
<td>7.2</td>
</tr>
</tbody>
</table>

*Note: M=Male, F=Female
Variables refer to persons age-adjusted to the 2000 standard population
* There are age adjusted
* Information for propane leak was strong for 34 deaths

Source: CDC Wonder
Risk Factors for Developing Asthma: Genetic Characteristics and environmental triggers

Allergy - Atopy:
- A predisposition to develop an antibody called immunoglobulin E (IgE) in response to exposure to environmental allergens.
- IgE be measured in the blood.
- Includes allergic rhinitis, asthma, hay fever, and eczema.

Non-allergic mechanism:
- Any allergic and non-allergic triggers in the medical history.

Symptoms occur or worsen in the presence of:
- Exercise
- Viral infection
- Animals with fur or hair
- House-dust mites (in mattresses, pillows, upholstered furniture, carpets)
- Mold
- Smoke (tobacco, wood)
- Pollen
- Changes in weather
- Strong emotional expression (laughing or crying hard)
- Airborne chemicals or dusts
- Menstrual cycles.

Yes, we do house-calls

The sentinel health investigation objective:

- Assess occurrence of disease
- Identify environmental or occupational exposure
- It may be used for preventive measures

(J. Last, MD, MPH)
Case 2: Mother is always right!

Child with Asthma in Spanish Harlem

Medical history

Mother calls and reports:
11 y girl with repeated asthma attacks in home in New York City
Missed school due to doctor/ER visits
On vacation in the Caribbean's doing better
Upon questioning:
Brother with asthma

- History of recurrent bouts of asthma, pneumonia, bronchitis, sinusitis, and middle ear disease.
- Prior diagnosis of velo-cardio-facial syndrome (a variant of DiGeorge syndrome or a.k.a catch 22 disease)
- Associated with T-cell deficits and susceptibility to infections.

Her catch 22 doctors told the mother and “it’s related to her genetic disease”

This is what we saw at a home visit:
Sentinel Case 2

30 y female museum worker/volunteer

Symptoms:
- Gastro-intestinal (likely Gallbladder attack) –
- went to Bellevue – ER earlier
- Respiratory problems
- Fever/chills / cold-sweats
- Myalgia (muscle aches)
- Hand rash
- Liver tenderness
- Immune function problems
- Anorexia
- Neuro-cognitive problems

Handled moldy cardboard / paper in basement for 3 days unprotected
IgE Antibody tests and distribution

A sentinel health investigation

Case 2: 15 y Girl from North Philadelphia – vs PHA

- Status asthmaticus with cardiopulmonary arrest of unknown duration
- Anoxic encephalopathy, secondary to cardiopulmonary arrest
- Profound mental retardation secondary to cardiopulmonary arrest
- Status post tracheotomy, feeding disorder, status post gastrostomy tube placement (G-tube), spasticity, osteopenia, pulmonary interstitial lung disease (allergic or inflammatory etiology), sepsis, MRSA positive, diabetes mellitus, recurrent pneumonia...
Philadelphia Housing Authority, Others Settle Mold-Related Claims For $11.78 Million

- McKinney and her children alleged that they suffered unsafe conditions in the HCVP-approved home, including damp conditions and mold contamination.

Environmental findings

- Evidence of water damage visible
- Visible mold in different rooms
- Also findings of
  - PE: IgE antibodies showed reactions to the tested molds (Aspergillus f., Penicillium c/n., and Cladosporium h.) and mild to borderline reactions to other environmental allergens

Environmental sampling:
- Mold: Allergenic/toxigenic fungi 5000 to 10000 spores/m³
- Stachybotrys c. 10000 spores/m³
- Mycotoxins screening - high toxicity
- Endotoxins: 14,000 to 910,000 EU/gm
- Allergens: Non-detectable (low to dust mite, cockroach, dog)
- Pesticides: Non-detectable
- Lead: Not substantial (<300 mg/kg)

Workshop conclusion

Children in homes with dampness and/or mold, higher risk:

"...upper respiratory symptoms...
...lower respiratory tract symptoms...
...skin symptoms...
...systemic symptoms (HA, fatigue, joint pains)...
...food intolerance...
...unusual symptoms with high exposure...
...nosebleed and hemoptysis."
Clearing the Air: Indoor Air Exposures & Asthma (IOM 2000)

### Biological Agents
- Sufficient evidence of causal relationship
  - Cat
  - Cockroach
  - House dust mite

- Sufficient evidence of an association
  - Dog
  - Fungus/Molds
  - Rhinovirus

- Limited or suggestive evidence of association
  - Domestic birds
  - Chlamydia and Mycoplasma pneumonia
  - RBV

### Chemical Agents
- Sufficient evidence of causal relationship
  - Environmental tobacco smoke (among pre-school aged children)

- Sufficient evidence of association
  - NO₂, NOₓ (high levels)

- Limited or suggestive evidence of association
  - Environmental Tobacco Smoke (among school-aged, older children, and adults)
    - Formaldehyde
    - Fragrances

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**Toxicology, Epidemiology Focus on Lung Damage**

- Numerous epidemiology studies of dampness and mold exposure lead to conclusions that asthma and other respiratory problems are caused and made worse by exposure

- New asthma in healthy people exposed to mold is non-allergic, as well as allergic (WHO, 2009; Quaner et al., 2011; Mendel et al., 2012)

- Mycotoxins as causative agents are supported by toxicologic investigations (Miller et al., 2010)

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**Work-related asthma: Most frequently reported agent categories associated with cases of work-related asthma, 1993–2002**

![Graph showing work-related asthma agents](http://www2a.cdc.gov/drds/WorldReportData/pdf/2007F09-01.pdf)
Distribution of agent categories most frequently associated with WRA cases for all four SENSOR reporting States (California, Massachusetts, Michigan, New Jersey), 1993-1999.


Take home messages

- Incorporating environmental screening questions into the patient history can identify potential exposures in the home that may be contributing to patients' symptoms.
- A comprehensive environmental history should include types of exposures, exposure assessment, time between exposure and symptom onset, and occupational exposures and employment history.
- Referral to an environmental and occupational medicine specialist may be appropriate for patients who need additional resources or assistance.
HUD recommendations

Keep a clean home:
- Keep your home free of dust, mold, smoke, and other potential triggers.
- Vacuum often with HEPA (High Efficiency Particle Air) filter.
- Store foods in sealed containers to avoid attracting cockroaches and rodents.
- Clean countertops, sinks, and dry dishes immediately.

Keep people with asthma away from dust, dust mites, and smoke:
- Use zippered "allergen resistant" mattress and pillow covers to keep dust mites out of sleeping spaces.
- Quit smoking, or smoke only outside your home and car. Always keep tobacco smoke away from children.
- Change bed sheets often.
- Keep people with asthma out of a room while vacuuming or dusting.

Get medical advice and follow the doctor’s instructions!

Diagnosis

PRACTICE AND CHALLENGES

Environmental HISTORY

- What kind of work do you do?
- What home do you live in?
- What symptoms do you have in time and place
- How long?
- What exposures are involved?
- Family members with health issues?
- Hobbies or Crafts
Differential diagnostic problem

- Exposure
- Multiple
- Mixture
- - dose

Non-specific symptoms
Multiple disease endpoints

Diagnostic challenge: Various agents and disease outcomes

Agents:
- Allergens (Animal; plant)
- Bacterial compounds
- Ergosterol
- (1,3)-ß-D-glucan
- Mycotoxins
- microbial volatile organic compounds (MVOCs)

Possible disease outcomes:
- Allergy + Non-allergic
  - Dermatitis,
  - Urticaria
  - Rhinitis, Sinusitis
  - Asthma
  - Extrinsic allergic alveolitis
  - "humidifier fever"
  - Organic dust toxic syndrome
  - Toxic – irritant effects

Medical Diagnosis

- History
- Physical examination
  - Blood work (IgE)
  - Chest x-ray
  - Breathing test
  - PFT +/- diffusion
  - Challenge test

- Auscultation
  - Use of accessory muscles
  - Heart rate
  - Respiratory rate
  - Peak expiratory flow
  - Oxygen saturation (pulse-ox)
What is asthma?

• Chronic inflammatory disorder of the airways
  • Mast cells, eosinophils, T lymphocytes, airway macrophages, neutrophils, and epithelial cells.
  • Signs and symptoms:
    • wheezing, breathlessness, chest tightness, and coughing,
    • particularly at night or in the early morning.
  • variable airflow obstruction
    • that is often reversible either spontaneously or with treatment.
  • increase in the existing bronchial hyper-responsiveness to a variety of stimuli.

Asthma Pathology + Diagnosis

• The diagnosis of asthma is established by the presence of reversible airway obstruction.
• Spirometry pre-bronchodilators and post-bronchodilators
• Nonspecific broncho-provocation test
• Airway obstruction is generally present when FEV1 is less than 80% of predicted value and a reduction in the FEV1/FVC ratio exists.
• Airway obstruction is considered reversible if an increase of at least 12% in the FEV1 with a minimal absolute increase of 200 ml occurs after the administration of a short-acting, inhaled β-agonist.
Asthma differential diagnosis

- Allergic vs non-allergic type asthma
  - Allergic asthma due to hypersensitivity to allergens / atopy
  - Non-allergic asthma (a.k.a irritant-induced asthma or reactive airways dysfunction syndrome)
  - After accidental exposure to a high level of a respiratory irritant gas, vapor, fume, aerosol, or dust
- Intrinsic vs extrinsic asthma
  - Adult-onset asthma vs juvenile asthma
- Atopy, the genetic predisposition to develop IgE antibodies against allergens, is the foremost predisposing factor for the development of asthma.
- Factors associated asthma include
  - allergic rhinitis,
  - nasal polyps,
  - and sinusitis.
  - Asthma and allergic rhinitis are frequently found in the same patient.

Asthma Management

- Table 1: Classification of chronic disease severity
  - m, moderate; s, severe
  - Immunotherapy: at home, under doctor's supervision
  - Breakthrough: up to +3 tablets per day
  - Oral corticosteroids: prednisone, dexamethasone
  - Long-acting beta agonists: formoterol, salmeterol
  - Inhaled corticosteroids: fluticasone, budesonide
  - Long-acting muscarinic antagonists: tiotropium, aclometoprine
  - Exacerbation: oral or intravenous corticosteroids, inhalation of short-acting beta agonists
  - Refractory: oral corticosteroids, preventative maintenance therapy
  - Management: education, environmental control, pharmacological treatment

Asthma Management

- Confirmation of asthma diagnosis
- A measure of severity
- Prevention of chronic asthma symptoms and exacerbations day and night
- Normal activity maintained (including exercise and other activities)
- Normal or near-normal lung function
- Optimal pharmacotherapy with minimal or no adverse effects
- Careful monitoring
- Education of the patient and family regarding primary and secondary preventive measures.

Asthma treatment

1) Medical removal from offending agent
Reasons: low concentration can provoke serious asthma
Repeated low-level exposure can lead to irreversible airways obstructive disease in sensitized patients
High concentrations (i.e., chemical spill, Latex) can lead to non-allergic asthma, acute severe asthma attack, possible death in sensitized person

2) Symptomatic treatment:
See guidelines, references and The Medical Letter

Combining inhaled corticosteroids and long-acting beta-agonists leads good asthma control and improvement
Risk Factors for Asthma-Related Death

- Comorbidities
  - (i.e., cardiovascular or other lung disease)
  - Illicit drug use
  - Psychiatric disorders
- Difficulty perceiving airway obstruction or severity of exacerbation
- Low socioeconomic status or inner-city residence
- Previous severe exacerbation
  - (e.g., intubation or admission to intensive care unit for asthma)
- Two or more hospitalizations or three or more emergency department visits in the past year
- Two or more refills of short-acting beta2 agonists per month
Indoor Exposures

- Dust mite allergen
  - (carpet, bedding, stuffed toys)
- Cockroach allergen
- Cat allergen
- Dog allergen
- Dampness indoors/homes
- Fungi/Mold
- Secondhand Tobacco Smoke
- Indoor Chemicals (fragrance, other)
- NO₂ (gas appliance in poorly ventilated kitchen)

Outdoor Air Exposures

- Ozone
  - Causes asthma among children, associated with increased ER visits among people with asthma
- Fine Particulate Matter (PM)
  - Associated with increased ER visits
  - Tiny particles from dirt, soot, smoke, fuel
- Carbon Monoxide
  - Exacerbates symptoms
  - Combustion from motor vehicles, wood smoke
- Nitrogen Oxides (NOₓ)
  - Exacerbates symptoms
  - Fuel emissions from vehicles, power plants
- Sulfur Dioxide (SO₂)
  - Exacerbates symptoms
  - Industrial sources

Hurricane “Katrina” 2005
“Sandy” 2012
“Haiyan” 2013

Flood Risk

Superstorm and destruction more likely:
- Warming sea level rise (US East Coast 4x faster)
- 5-10% more rain fall
- Water vapor and higher ocean temp fuel storm
- Unusual path of storm
- “Katrina-magnitude events have been twice as frequent in warm years compared with cold years”
Storm clean-up

Volunteer & Professional Clean-up

Remediation guidance
Medical clearance
Personal protective equipment (PPE)
Respiratory Protection

The New York City Dep Health Guidelines

Meeting convened by Mt. Sinai Occupational Clinic with NYC-DOH (1993)
Expert opinions...? Starting point: “toxic mold”

Key points:
- Assessment (visual inspection often sufficient)
- Remediation
  - Remove water damaged material
  - HEPA filter negative pressure
- Exposure Control for workers and by-standers
- Protective Equipment including respiratory protection

http://www.health.ny.gov/publications/7287/
The state of a building can have an impact on health, and the health effects of chronic water infiltration are well recognized.

Microbial fragments and products, associated with respiratory problems (irritant, allergic and other types of reactions) and effects on other systems.

Effects on other systems and will vary according to the type and extent of exposure and a host of individual factors (age, atopy, etc.).

Removing moldy walls – enough?

Reminder Guideline Publications:
- Family Doctor • A Journal of the New York State Academy of Family Physicians (2013)
- Journal Environmental Health and Preventive Medicine (2014)

Pointer to respiratory hazards: MSDS
Environmental and Occupational Health Resources

U.S. Department of Housing and Urban Development (HUD): Asthma
http://portal.hud.gov/hudportal/HUD?src=/program_offices/healthy_homes/healthy_homes/asthma

Agency for Toxic Substances and Disease Registry
Federal public health agency that provides health information to prevent harmful exposures and diseases related to toxic substances. Web site: http://www.atsdr.cdc.gov/

American College of Occupational and Environmental Medicine
Organization representing physicians and other health care professionals specializing in the field of occupational and environmental medicine. Web site: http://www.acoem.org/

Association of Occupational and Environmental Clinics
A nationwide network of more than 60 multidisciplinary clinics and more than 290 occupational and environmental medicine professionals. Web site: http://www.aoec.org/

National Institute for Occupational Safety and Health
Federal agency responsible for conducting research and making recommendations for the prevention of workplace illness and injury. Web site: http://www.niosh.gov/