

CHILDREN'S HEALTH & AIR QUALITY

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June 2011

OBJECTIVES

- Survey associations between major air pollutants and child health
- Focus on asthma
- Explore impact of individual pollutants
- Discuss management strategies
- Case presentation

MAJOR AIR POLLUTANTS

- Ozone
- Particulate matter (PM)
 - PM_{2.5}—particles with aerodynamic diameter <2.5 micrometers (mcm)
 - PM₁₀—particles with aerodynamic diameter <10 mcm
- Carbon monoxide
- Nitrogen oxides
- Sulfur dioxide
- Lead

ASSOCIATIONS BETWEEN MAJOR AIR POLLUTANTS AND CHILD HEALTH

- Significant evidence
 - Asthma episodes
 - Lower respiratory tract infections
- Limited evidence
 - New incidence of asthma
 - Childhood leukemia
 - Sudden infant death syndrome
 - Middle ear infections
 - Preterm birth
 - Small for gestational age
 - Cardiac birth defects

WHAT IS ASTHMA?

- A chronic inflammatory disorder involving:
 - Airway edema (swelling)
 - Mucus hypersecretion
 - Formation of mucus plugs that limit airflow
 - Inflammation and swelling of the smooth muscle of the airways themselves.
 - Airway hyperresponsiveness
 - Exaggerated constriction response to stimuli
 - Bronchoconstriction
 - Airways constrict in response to irritants and allergens

ASPECTS OF ASTHMA

- Symptoms
 - Cough
 - Wheezing
 - Chest tightness
 - Shortness of breath
- Causes
 - Genetics
 - Environmental factors
 - Allergens
 - Irritants
 - Tobacco smoke
 - Air pollution
 - Infections
 - Immune responses

ASTHMA EPIDEMIOLOGY

- Prevalence
 - 2009: 24.6 million Americans (8.2% of the population)
 - Prevalence has risen across all demographic groups since 2001
 - Prevalence among children: 9.6%
 - Most common chronic condition of childhood
- Impact
 - 18 BILLION dollars/ yr
 - 40,000 school or work absences DAILY
 - 5000 emergency room visits DAILY (@2 million/yr)
 - 1000 hospitalizations DAILY
 - 11 deaths DAILY (@4000/ yr)

ASTHMA DISPARITIES

- Income: Prevalence greater among poor adults and children
- Ethnic
 - African-Americans (AA): 3x greater rate of hospitalization
 - Non-Hispanic black children most affected of all children (17%)
 - Hispanics
 - Puerto Ricans: Greater rates and severity of asthma compared to other Hispanic subgroups.
 - Hispanic children: Higher rates of asthma compared to non-Hispanic whites.
- Gender
 - Women: 65% of asthma deaths
 - AA women: Highest mortality rate of all groups

ASTHMA IN INDIANA

- Prevalence:
 - 435,000 adults (2009)
 - 140,000 children (2005): 8.4% of Hoosier children
- Morbidity
 - Hospitalizations: 9,100 (2009)
 - Deaths: 66 (2007)
- Disparities
 - Women: Higher mortality rate and prevalence
 - African-Americans: More ER visits and hospitalizations
 - Children under age 5, and adults over age 65y: Higher rates of hospitalizations

CHILDREN AND AIR POLLUTANTS

- Greater impact vs adults because:
 - Children breathe more air per unit body weight at rest
 - Greater activity levels
 - Spend more time outdoors, esp in afternoon hours
 - Lung development continues until adolescence.
- As of 2002: 150 million Americans lived in areas that did not meet air quality standards for at least one of the major air pollutants.

MAJOR AIR POLLUTANTS: OZONE (O₃)

- Summertime smog
- Outdoor sources--Generated by chemical reactions between:
 - Volatile organic compounds, (eg, hydrocarbons from motor vehicles, chemical and power plants, etc) and
 - Nitrogen oxides (motor vehicles, power plants)
 - Reactions triggered by sunlight and heat
- Indoor sources
 - Ozone generating air purifiers
 - Xerographic copy machines
- Levels higher during warmer months

IMPACT OF OZONE

- Often the most significant outdoor air pollutant associated with asthma symptoms
- Short-term exposure
 - Increased asthma symptoms and medication use
 - Increased respiratory infections
- Early childhood exposure
 - Reduced lung function growth
 - Increased airway inflammation.
- EPA standards (in parts per million per volume of cubic meter of air, in an 8-hour period): 0.075 ppm/m³.

MAJOR AIR POLLUTANTS: PARTICULATE MATTER (PM_{2.5} & PM₁₀)

- Often second to ozone in triggering asthma symptoms.
- PM₁₀—can enter respiratory system
- PM_{2.5}—can reach alveoli
- Indoor sources
 - Tobacco smoke
 - Wood-burning fireplaces & stoves
 - Dust
- Outdoor sources: Combustion by-products of:
 - Factories
 - Motor vehicles
 - Power plants

IMPACT OF PM

- Early life exposure to PM₁₀ related to increased risk of asthma diagnosis.
- More frequent respiratory symptoms
- Greater medication use
- Decreased lung function, with elevated PM_{2.5} levels.
- Increased cardiovascular morbidity and mortality (adults)
- Increased effects with warm weather
- EPA standards (for 24 hr period, in mcg/ cubic meter of air)
 - PM_{2.5}: 35 mcg/ m³
 - PM₁₀: 150 mcg/ m³

MAJOR AIR POLLUTANTS: CARBON MONOXIDE (CO)

- Early life exposure related to increased risk of asthma diagnosis.
- Associated with ER visits for cardiac issues (adults)
- Sources: Indoor and outdoor fuel-burning appliances and vehicles
- EPA standards: 9 ppm/ (10mg/m³), in an 8-hr period.

MAJOR AIR POLLUTANTS: SULFUR DIOXIDE (SO₂)

- Early life exposure related to increased risk of asthma diagnosis.
- Decreased lung function
- Mainly outdoor pollutant
 - Formed by combustion of high-sulfur coal or oil
- EPA standard: 0.14 ppm, in a 24-hr period.

NITROGEN OXIDES (NO_x)

- Early life exposure related to increased risk of asthma diagnosis.
- Increased asthma symptoms
- Lowered lung function
- Major sources
 - Auto exhaust (#1)
 - Power plants
 - Forest fires
- EPA standard: 100 ppb/ hour
- Symptoms associated at levels below EPA standards.

AMBIENT METALS

- Lead
 - No safe level of exposure
 - Sources: Paint (pre 1978), industry
 - Cognitive, developmental, hematologic and neurological effects
- Nickel and vanadium
 - Sources: Heating oils and auto exhaust
 - Associated with wheezing in young children

ENVIRONMENTAL TOBACCO SMOKE (ETS)

- Largest single source of fine particulates in homes with smokers
- Contains many of the same compounds found in diesel exhaust
- Increased inflammation and DESTRUCTION of the airways
- Increased allergen sensitization and airway hyperresponsiveness
- Increase incident asthma rates and asthma exacerbations

AIR QUALITY INDEX (AQI)

- EPA-provided index about
 - local air quality,
 - Potential effects, and
 - Actions that can be taken to protect themselves
- www.airnow.gov
- www.smogwatch.IN.gov
- Based on
 - Ground level ozone
 - Particulate matter
 - Nitrogen oxides
 - Sulfur dioxide
 - Carbon monoxide

AIR QUALITY INDEX

RANGE	AIR QUALITY	COLOR
0-50	GOOD	GREEN
51-100	MODERATE	YELLOW
101-150	UNHEALTHY FOR SENSITIVE GROUPS (INCLUDES ASTHMA)	ORANGE
151-200	UNHEALTHY	RED
201-300	VERY UNHEALTHY	PURPLE
301-500	HAZARDOUS	MAROON

MANAGEMENT

- Eliminate indoor, car, (and outdoor) smoking
- Reduce outdoor emissions (auto, power plants, factories)
- Use air conditioning
- Stay indoors when AQI>100(orange or greater)
 - Knozone action days
- Address allergies
- Compliance with asthma medication regimen
- Consistent follow-up with health care providers regarding asthma.

CASE PRESENTATION

- Mary is 5yrs old
- Lives in Northwest Indiana, near factories
- Asthma since infancy; multiple ER visits in recent months
- Family has seen pediatrician consistently, and appears to be compliant with medicines
- Social history:
 - Mother's boyfriend smokes
 - Family has used propane space heaters in the past

REFERENCES

- [Wigle DT, Arbuckle TE, Walker M et al. Environmental hazards: evidence for effects on child health. J Toxicology and Environmental Health, Part B. 10: 3-39, 2007.](#)
- <http://www.nhlbi.nih.gov/guidelines/asthma/asthsumm.pdf>
- Centers for Disease Control. Vital signs: Asthma prevalence, disease characteristics, and self-management education—United States, 2001-2009. MMWR. 60: 1-7, May 3, 2011.
- <http://www.aafa.org/display.cfm?id=9&sub=42>
- <http://minorityhealth.hhs.gov/templates/content.aspx?lvl=3&lvlID=532&ID=6173>
- http://www.in.gov/isdh/files/Asthma_fs_12-22-10.pdf (ISDH, Asthma in Indiana 2010 factsheet.)
- http://www.in.gov/isdh/files/Final_3-13-08.pdf (The Burden of Asthma in Indiana, 2nd ed, March 2008)
- <http://www.epa.gov/air/criteria.html>
- Diette GB, McCormack MC, Hansel NN et al. Environmental issues in managing asthma. Respir Care. 53(5): 602-17, 2008.
- Laumbach RJ. Outdoor air pollutants and patient health. Am Fam Physician. 81(2): 175-180, 2010.

REFERENCES

- Akinbami LJ, Lynch CD, Parker JD, & Woodruff TJ. The association between childhood asthma prevalence and monitored air pollutants in metropolitan areas, United States, 2001-2004. *Env Res.* 110: 294-301, 2010.
- Clark NA, Demers PA, Karr CJ et al. Effect of early life exposure to air pollution on development of childhood asthma. *Env Health Persp.* 118: 284-290, 2010.
- Stieb DM, Szyszkowicz M, Rowe BH & Leech JA. Air pollution and emergency department visits for cardiac and respiratory conditions: a multi-city time-series analysis. *Env Health* 8:25, 2009.
- Oconnor GT, Neas L, Vaughn B et al. Acute respiratory health effects of air pollution on children with asthma in US inner cities. *J Allergy Clin Immunol* 121: 1133-9, 2008.
- <http://www.lungusa.org/healthy-air/outdoor/resources/lead.html>
- Eggleston PA. Complex interactions of pollutants and allergen exposures and their impact on people with asthma. *Pediatrics* 123: S160-7, 2009.