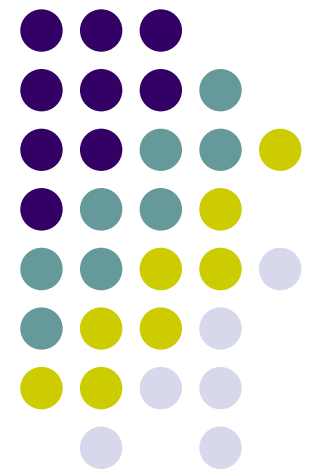


Animal Feeding Operations, Air Quality and Public Health

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Topics

- **Concerns voiced by the public**
- What is public health, why is it important?
- How is human respiratory health assessed?
- Air quality exposure assessment on farms
- How does air quality affect the health of livestock farm neighbors? Farmers?

Neighbor Health Concerns



- Odors, specific health effects, flies, noise
- Vulnerable persons included (children, the elderly, chronically ill)
 - Inclusion of vulnerable persons is how the public differs from the worker population
 - Healthy worker effect is a large factor





Public Health Concerns

- Respiratory diseases
 - Aggravation of asthma, other lung disorders
 - Possible causation of new lung disorders
- Non-respiratory issues
 - Psychological complaints
 - Other (a variety of symptoms reported)

Example #1 of AFO Neighbor Health Concerns



- Question: Parents of a child with recurrent pneumonia want to know if they should move because of a hog confinement facility being constructed 10 miles away.
 - The child's physician advised them to move to a community without this type of exposure because of risk to their child of having more lung infections

Example #2 of AFO Neighbor Concerns



- A farm family living 1 mile from 2 hog farms is alleging that one of the children has breathing difficulties when playing outdoors and that 2 of the children often vomit repeatedly at night
- They also object to the hog odor
 - Their family physician advised them to move away
 - They were also told by their doctor to stay in their basement when the hog odor is severe

AFOs, Air Quality & Public Health: The Health of Farm Neighbors



- High level of concern expressed by farm neighbors and others
- Published scientific information about exposures, respiratory and other health effects limited to a small number of studies describing exposures and symptoms

AFOs, Air Quality & Public Health: The Health of Workers

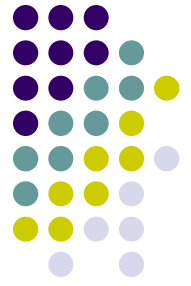


- Health effects might be expected to be similar in AFO workers and neighbors because exposures similar, **in terms of nature of the health condition, but with a lower prevalence**
 - ~30% of swine barn workers report lung symptoms
 - Lung inflammation associated with work in this setting
 - Review: Von Essen SG & Auvermann BW. J of Agromed 2005
- Limited interest expressed about worker health though exposures higher, many report respiratory symptoms
- Large amount of scientific information on exposures and respiratory health effects in AFO farm workers
 - Less information published on other health effects



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What is Public Health?

- Public health is concerned with threats to the overall health of a community based on population health analysis. The World Health Organization defines health as: “A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”
- The population in question can be as small as a handful of people or as large as all the inhabitants of several continents.

*From Wikipedia.

Also see Ten Essential Public Health Services at <http://www.asph.org/>

Why is public health important?



“Health care matters to all of us some of the time, public health matters to all of us all of the time.”

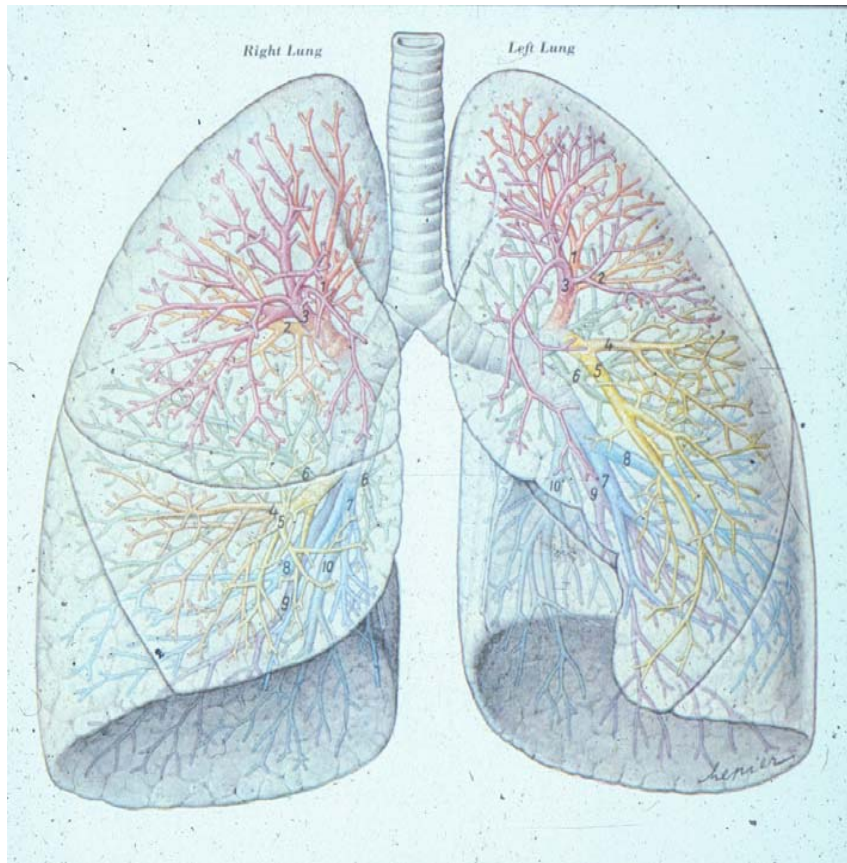
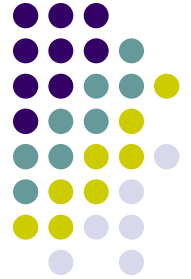
C. Everett Koop



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Normal Human Lung

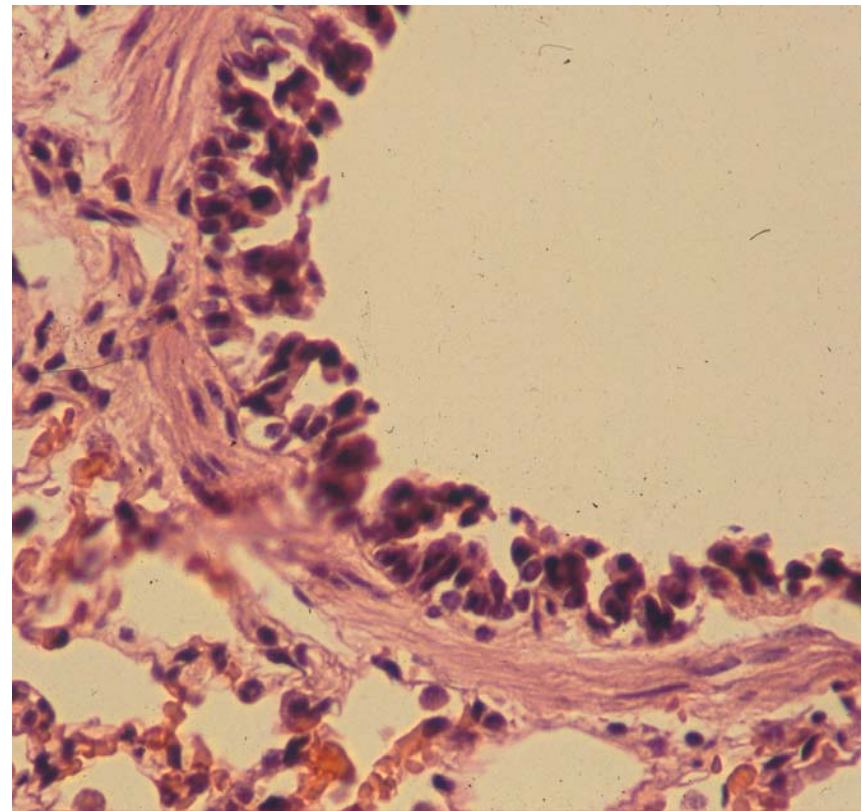


This drawing shows the major airways of the human lung

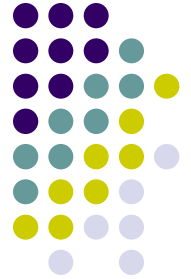


Airway and Alveolar Tissue

- Photomicrograph of an airway and adjacent alveolar tissue, where gas exchange occurs
 - 40X magnification



Assessment of Lung Health



- Questionnaires
 - Symptoms
 - Exposure assessment
 - Non-invasive, easily administered
 - Designing questionnaires that give informative data is a challenge



Assessment of Lung Health



- Lung function testing
 - Non-invasive and simple but may not detect subtle disease
 - Suitable for field studies
 - May be used for screening (see photo)



Assessment of Lung Health



- Bronchoscopy with bronchialveolar lavage
 - Information about cells, proteins in the lung
 - Pro: gives a lot of information
 - Con: invasive, expensive, must be done in a hospital
 - Used to study swine confinement farm workers in small numbers, not practical for studying neighbors
- Induced sputum
 - Also yields information on cells, inflammation
 - Can be done as a field study on livestock farms
 - Von Essen et al. Clin Toxicol 1998

Assessment of Lung Health



- Laboratory-based projects using animal models or cells in culture
 - Indirect means of studying mechanisms by which AFO exposures cause effects on the lung
 - Example: Poole JA et al. Repeat organic dust exposure-induced monocyte inflammation is associated with protein kinase C activity. *J Allergy Clin Immunol* 2007
 - Can test ideas generated by clinical studies
 - Gives evidence about which of the hundreds of substances in agricultural dusts are bioactive



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Exposure Assessment

- Estimating exposure from questionnaires
- Measuring dust levels, components of dust (mainly endotoxin to date), gases
 - Subjects wear personal air sampling equipment to collect dust then analyze samples in the lab
 - Non-invasive for subjects, but sampling and analysis technologies are complex
 - Measuring dust, gases in the air in barns or outdoors on or near livestock farms

What Contributes to Airway Disease in Swine Confinement Workers?



- Number of hours worked per day, years of exposure
- Substances in the air predict cross-shift decline in lung function and accelerated loss of lung function:
 - Total dust concentration TWA concentrations of ≥ 1.3 mg/m³ (smokers) or 2.8 mg/m³ (nonsmokers)
 - Ammonia levels of ≥ 7.5 ppm
 - Hydrogen sulfide, carbon dioxide, carbon monoxide measured and found not to be predictive
 - Donham KJ et al. Am J Ind Med 1995
- Endotoxin also affects lung function
 - Reynolds et al. Am J Ind Med 1996



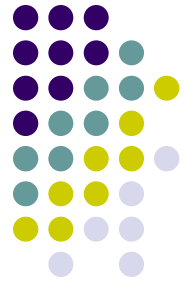
Neighborhood Exposure

- Reynolds et al measured hog dust and endotoxin 60 meters outside a facility
- Ammonia concentrations 0.25 ppm (large farms) to 0.14 ppm (small farms) at 60 M
 - 7.5 ppm of ammonia is the threshold for illness in the swine confinement workers
- Dust and endotoxin barely detectable at 60 M
 - Reynolds SJ et al. J Agromedicine 1997



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Neighborhood Health Effects (1)

- Schiffman et al studied 44 neighbors of hog confinement operations in North Carolina.
 - Results compared to rural resident controls
 - Used the Profile of Moods States questionnaire
 - More tension, anger, depression in hog farm neighbors
 - Also more confusion and fatigue, less vigor
 - Schiffman SS et al. Brain Res Bull 1995.

Neighborhood Health Effects (2)



- Thu et al studied 18 persons living within 2 miles of a hog confinement facility in Iowa as well as matched control subjects
 - More of the following symptoms in neighbors: cough, sputum production, chest tightness and wheezing. Also nausea, dizziness, weakness and fainting, headaches, plugged ears
 - No objective testing was performed
 - Thu K et al. J Agri Saf Health 1997



Neighborhood Health Effects (3)

- Wing and Wolf conducted 155 interviews on quality of life of persons living near hog farms, near farms with cattle or neither in North Carolina
- More respiratory and mucous membrane (nose and eye) complaints in those near hog farms
- Main finding: quality of life (number of times could open windows, go outside) reduced in hog farm neighbors compared to other groups
 - Wing S et al. Environ Health Perspect 2000

Neighborhood Health Effects (4)

Lung Symptoms in Rural Children



- Survey of 58,169 North Carolina adolescents
 - Respiratory symptoms, allergies, medications, socioeconomic class, household environments
 - Used public information on hog farms and schools
- More wheeze reported from schools within 3 miles of swine feeding operations (5% higher)
- Wheeze 24% higher if livestock odors noticeable indoors 2+ times per month
 - Mirabelli MC et al. Pediatrics 2006

Hog Confinement & Airway Disease in Workers



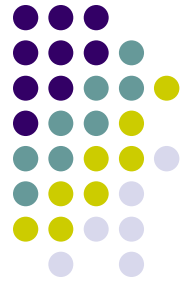
- Cough, wheeze, shortness of breath on exertion subacute or chronic in ~1/3 of workers
- Lung disorders
 - Asthma-like syndrome
 - See obstruction on lung function testing, as in asthma
 - Inflammation differs from asthma (not allergic)
 - Worsening of pre-existing asthma
 - Usually an irritant effect, very rarely from hog allergy
 - COPD
 - Hog barn exposure, cigarette smoking additive
 - Review: Von Essen SG & Auvermann BW. J Agromed 2005

Adaptation to Hog Barn Dust



- Persons who work in hog barns have less inflammation than do previously unexposed volunteers who spend only one day there
- This is evidence of an **adaptation** to substances in this environment, such as endotoxin
- Interesting question: Does adaptation occur in AFO neighbors as well?

Cattle Feedlots and Lung Health



New information on respiratory health in feedlot workers:

- **33 workers: questionnaire, lung function testing, personal air sampling for total dust and endotoxin**
- **25% of workers with shortness of breath, 9% with cough**
- **16% of workers reported having asthma**
- **12% of workers had obstruction on lung function testing**
- **Dust, endotoxin exposure, % with abnormal lung function tests similar to grain elevator workers from the same study**
 - **Grain workers can develop work related airway disease**

Findings presented by S. Von Essen at the American Thoracic Society meeting, held in San Francisco, May 2007 from work done in collaboration with SJ Reynolds and colleagues from Colorado State University

Neighborhood Effect: Summary



- More data is urgently needed on AFO health effects on neighbors
 - Studies need to be larger and should include vulnerable populations, control groups
 - Must include objective air quality assessment
 - Must include objective measures of health, including lung function
 - Must consider general health of subjects