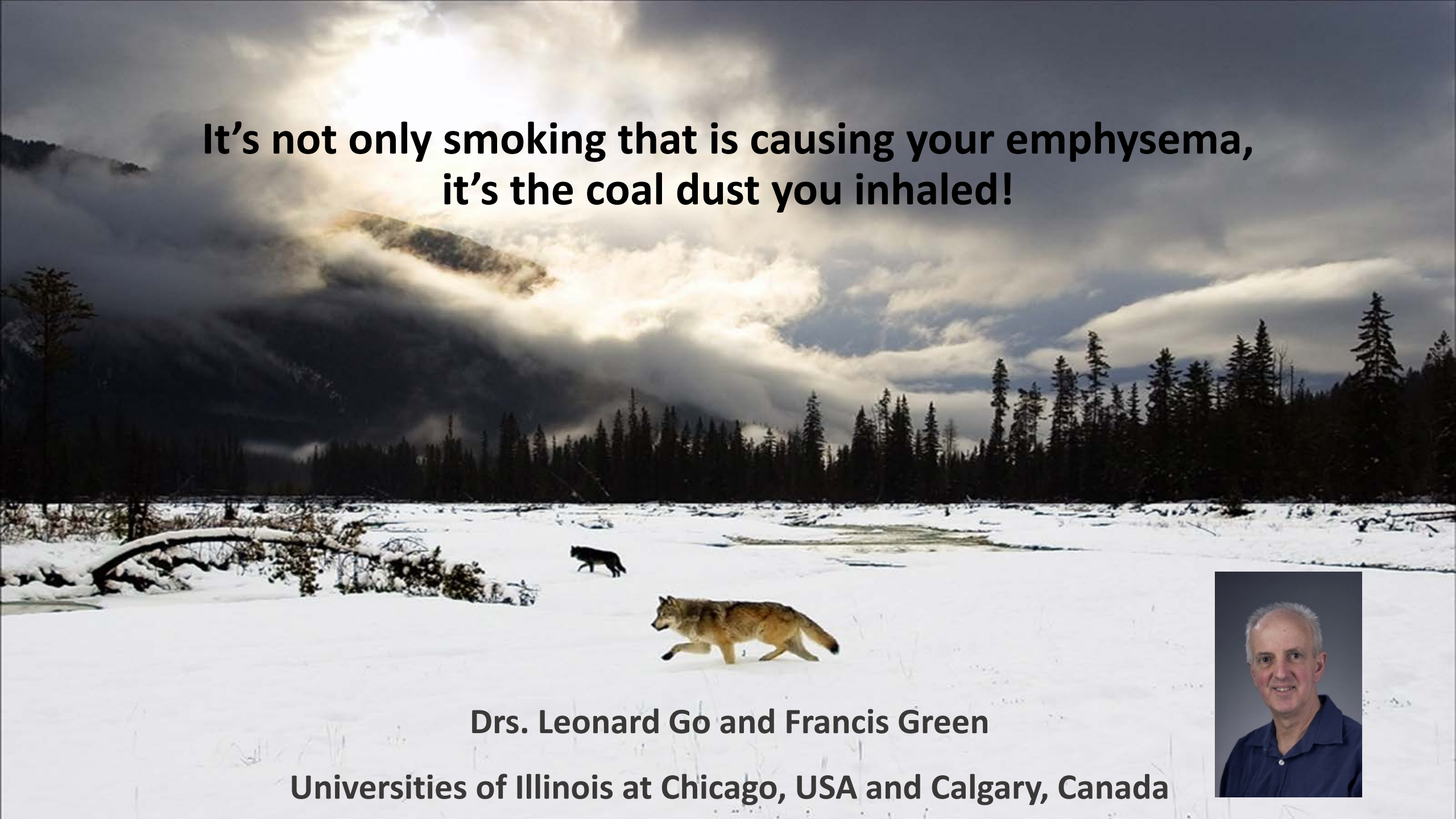
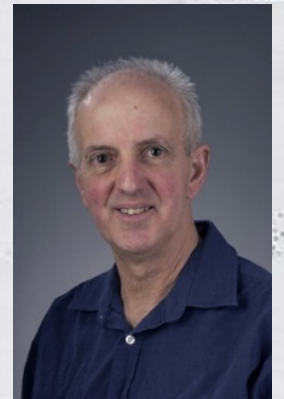


**It's not only smoking that is causing your emphysema,
it's the coal dust you inhaled!**



Drs. Leonard Go and Francis Green

Universities of Illinois at Chicago, USA and Calgary, Canada



Overview

- What is emphysema and how does it relate to Chronic Obstructive Pulmonary Disease (COPD)?
- How is it diagnosed?
- The pathogenesis (mechanisms of causation) of emphysema
- Does coal mine dust cause emphysema?
- Results from the NIOSH study of coal miners
- Summary and Conclusions

Common Myths about Emphysema and Coal Mine Dust

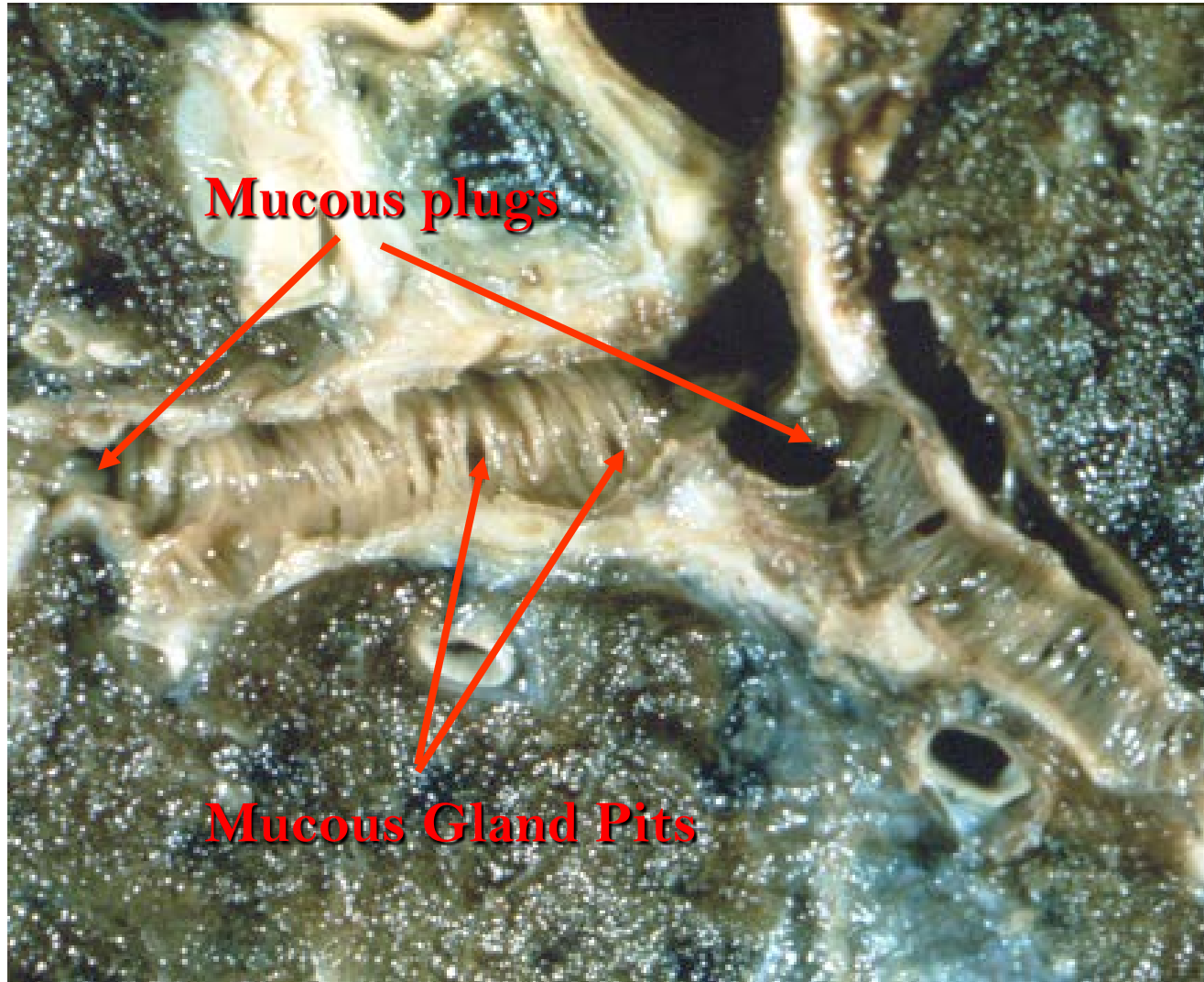
- “Smoking, not dust, is the main cause of COPD in coal miners”
- “Any emphysema caused by coal mine dust is trivial and does not contribute to your impairment”

COPD Includes

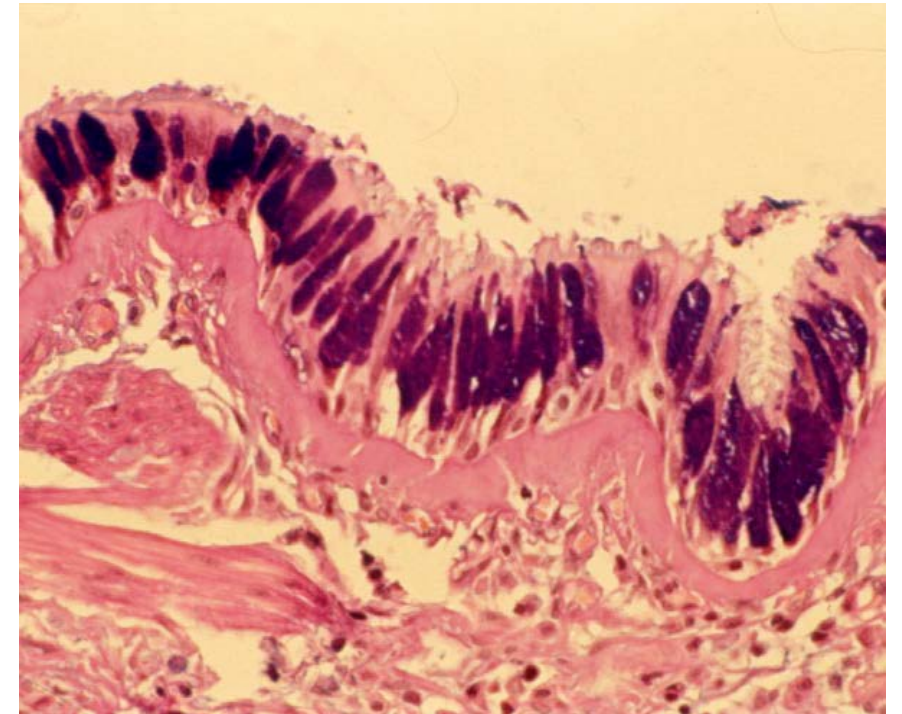
- Chronic Bronchitis
- Emphysema
- (Asthma)

These are distinct anatomic diseases but all are associated with chronic airflow obstruction and often occur together, hence the term COPD. Clinically they are primarily assessed by the FEV1 and CT scans

What is Chronic Bronchitis?



Increased mucus cells



What is Emphysema?

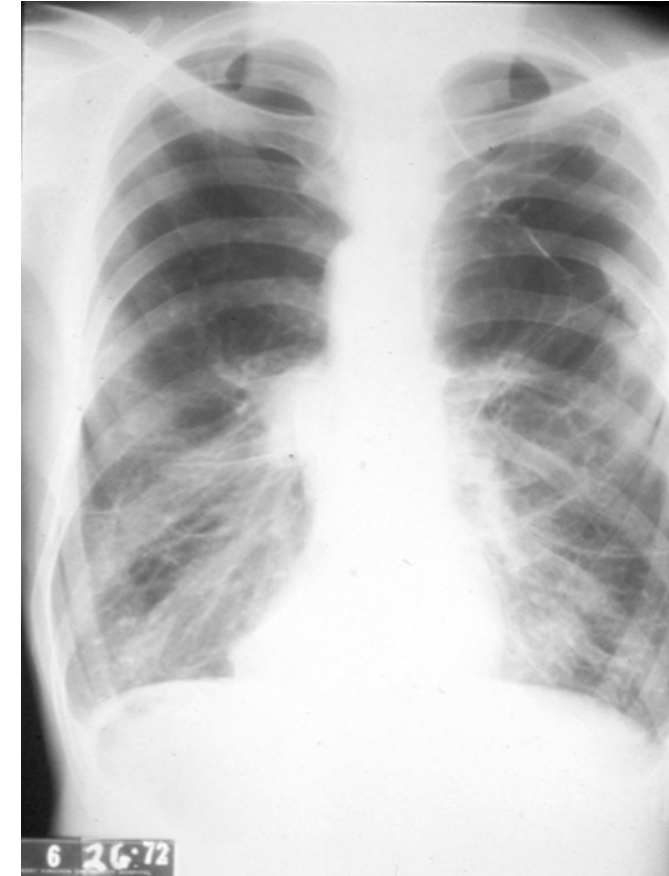
- A condition of the lung characterized by abnormal, permanent enlargement of the air spaces distal to the terminal bronchiole, accompanied by destruction of their walls and without obvious fibrosis*



Normal lung



Emphysema



Emphysema

*Snider GL et al., Ann Rev Resp Dis, 1985

Occupations and agents linked to increased risk for COPD

- Textiles
 - Cotton, flax, hemp
- Gases, fumes and smoke
 - Sulphur dioxide
 - Nitrogen dioxide
 - Isocyanates
 - Diesel emissions
 - Welding fumes
 - Cadmium and other heavy metals
 - Indoor open fire cooking (biomass burning)
 - Firefighting
 - Aluminum production
 - Urban air pollution
- Coal mining
- Hard rock mining
- Cement manufacturing
- Quartz
- Talc
- Woodworking
- Dust from the World Trade Center
- Poultry Farm dust
- Agricultural mineral dusts
- Etc.

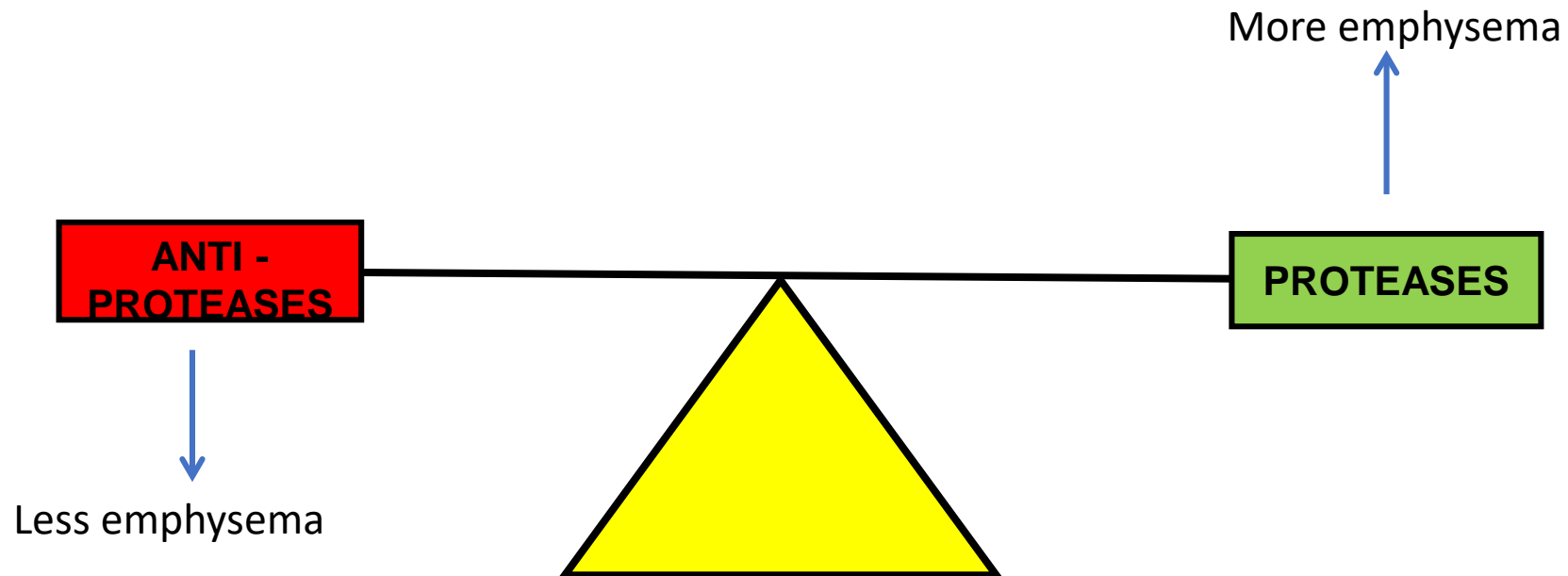
Note: All of these studies were controlled for cigarette smoking

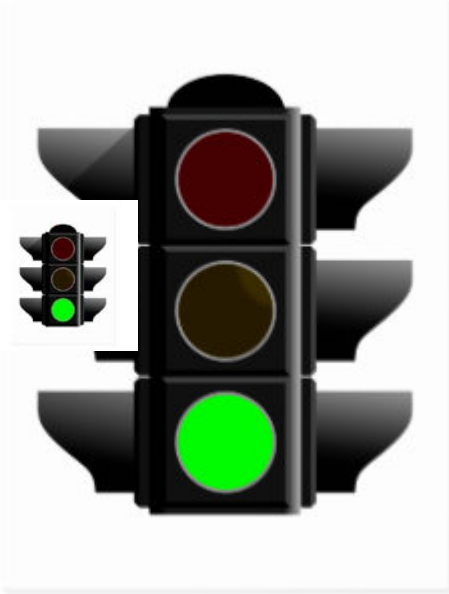
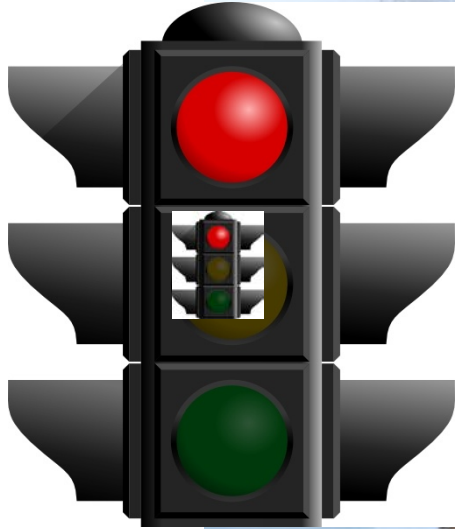
COPD and mineral dust exposure

- There are at least 44 epidemiologic studies that support the link between occupational exposure to mineral dust and obstructive lung disease after controlling for cigarette smoke and other variables, 35 of these were of coal miners. These showed:
 - Effect proportional to lifetime cumulative exposure
 - Effect seen with cat. 0 radiographic pneumoconiosis
 - Effect seen for all major coal mining populations
 - Vulnerable subgroups of miners identified
 - Effects of dust and smoking appear independent and additive

Biologic basis of Emphysema

- Inhibition of anti-proteases
- Excess proteases from inflammatory cells (macrophages and neutrophils)
- Decreased structural repair mechanisms
- Oxidant damage (free radicals of oxygen, smoke and dusts)
- All of these mechanisms apply equally to smoking and coal mine dust exposure



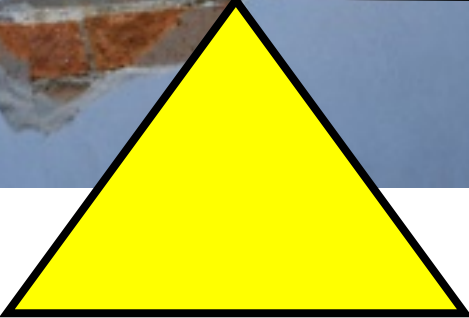


Less emphysema

**ANTI -
PROTEASES**

PROTEASES

More emphysema



Emphysema and Coal Mine Dust

- Leigh et al, OEM 1994
 - 264 deceased underground coal mine workers, NSW
 - Examined lung tissue for emphysema
 - Measured coal and silica dust content
- Results:
 - Strong relationship between extent of emphysema with coal content, age, and smoking

The relative contributions of coal mine dust and cigarette smoking to emphysema severity

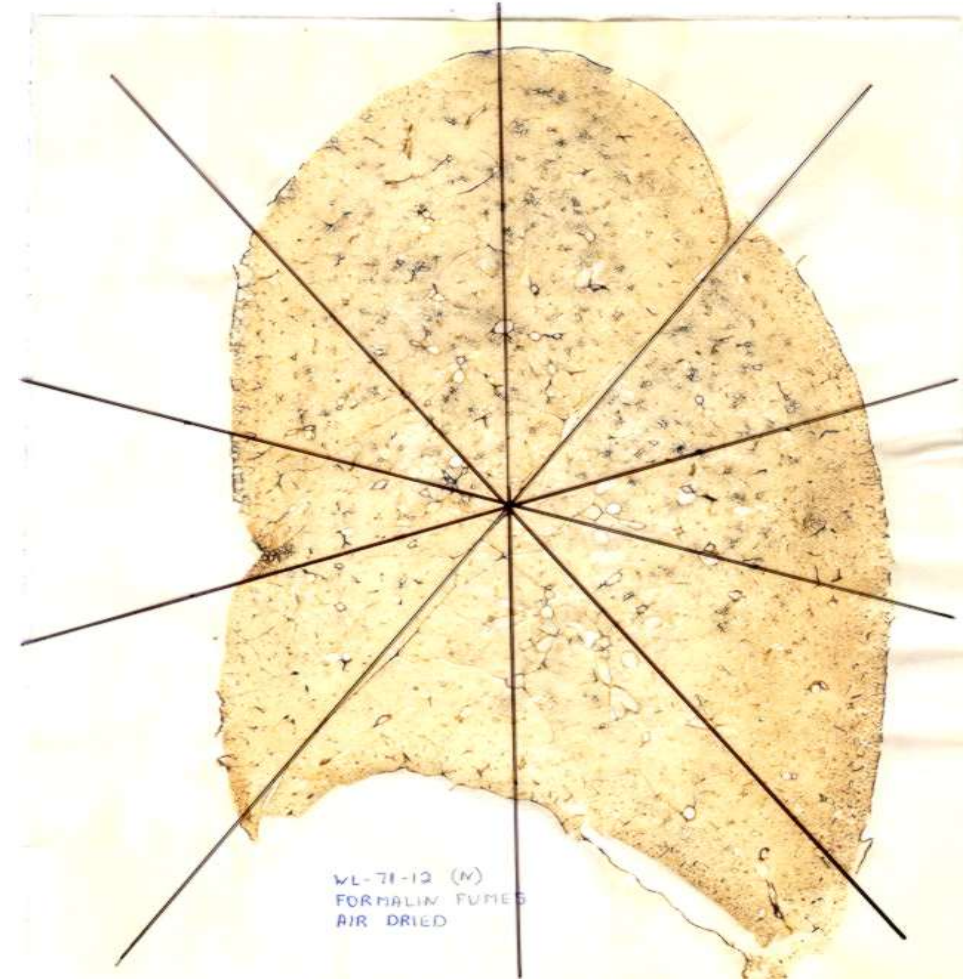
The NIOSH emphysema study

Methods

- 615 autopsied underground miners from West Virginia and 108 non-miners
- Information on
 - Years of mining
 - Jobs worked
 - Smoking
 - Medical histories
- Chest x-rays (N=466) and FEV₁ data (N=115) were available for some cases
- Estimates of airborne dust exposure based on mine, job categories and years of mining

The NIOSH emphysema study

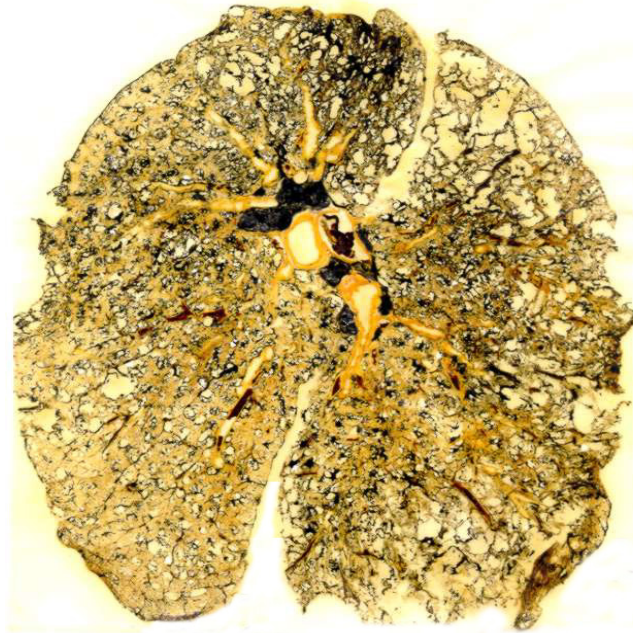
- Full autopsies with whole lung sections for estimates of type and severity of pneumoconiosis and emphysema
- For a subgroup of 131 miners, retained lung dust was available
- Grading of emphysema 100 points per segment



Examples of grades and types of emphysema in the coal miners



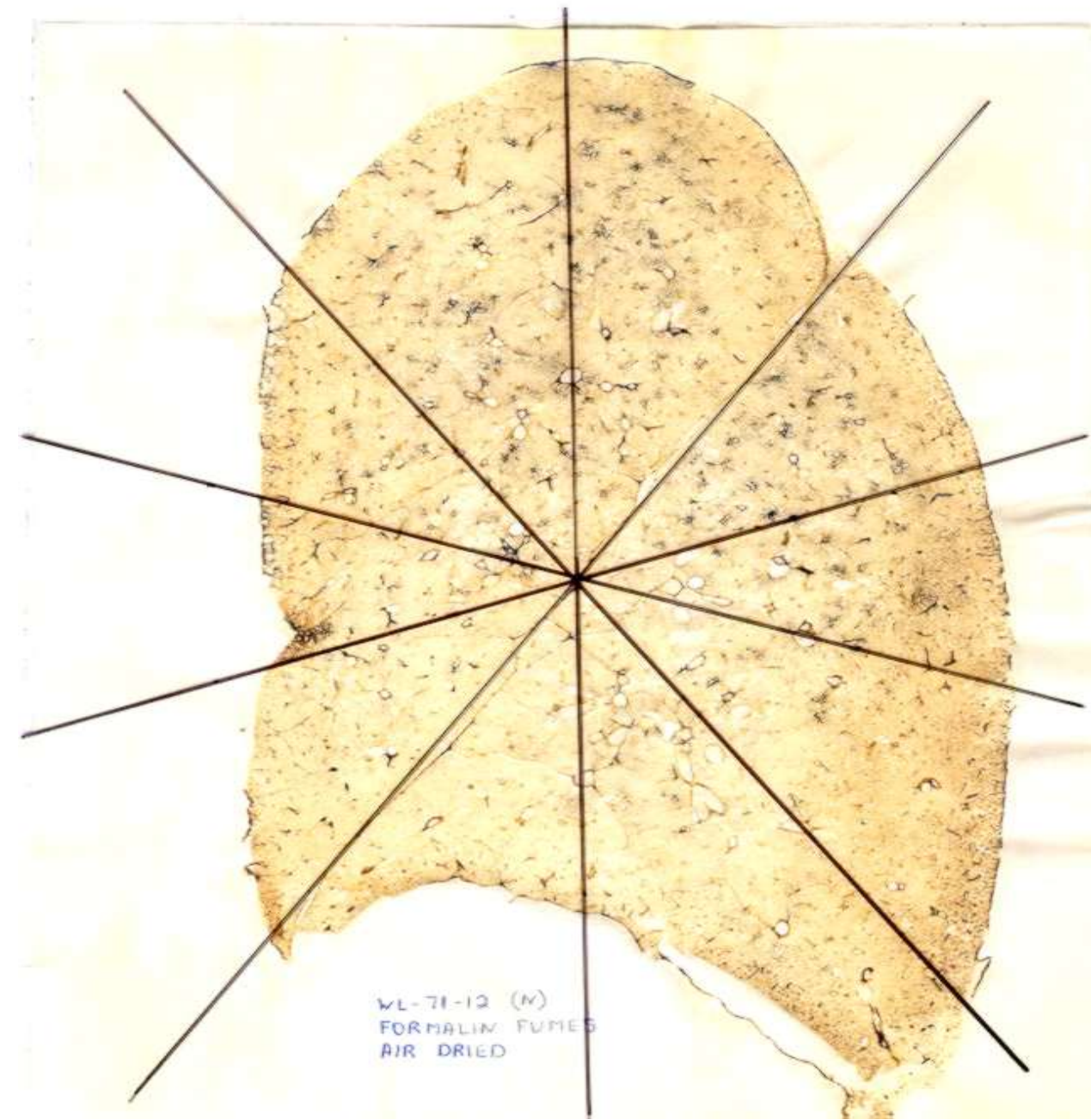
Macules and mild centriacinar (focal) emphysema



Moderate centriacinar and panacinar emphysema



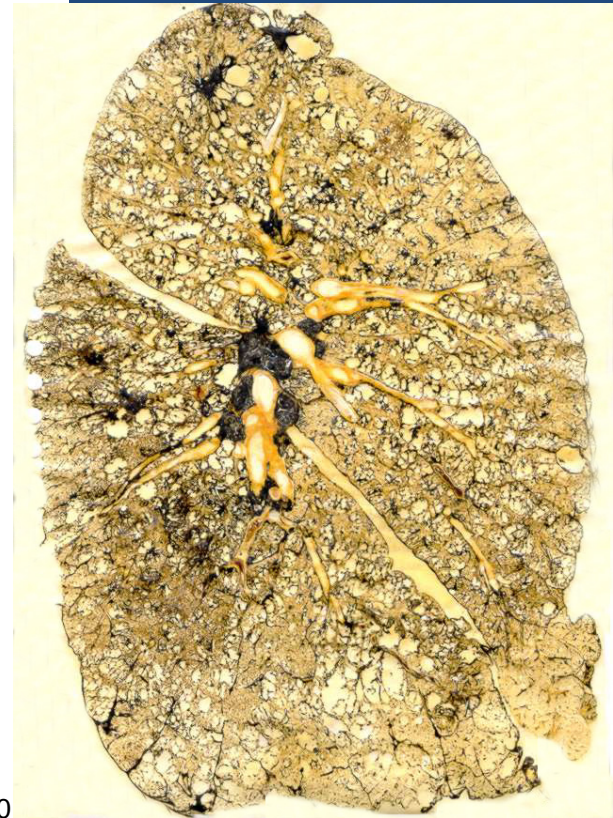
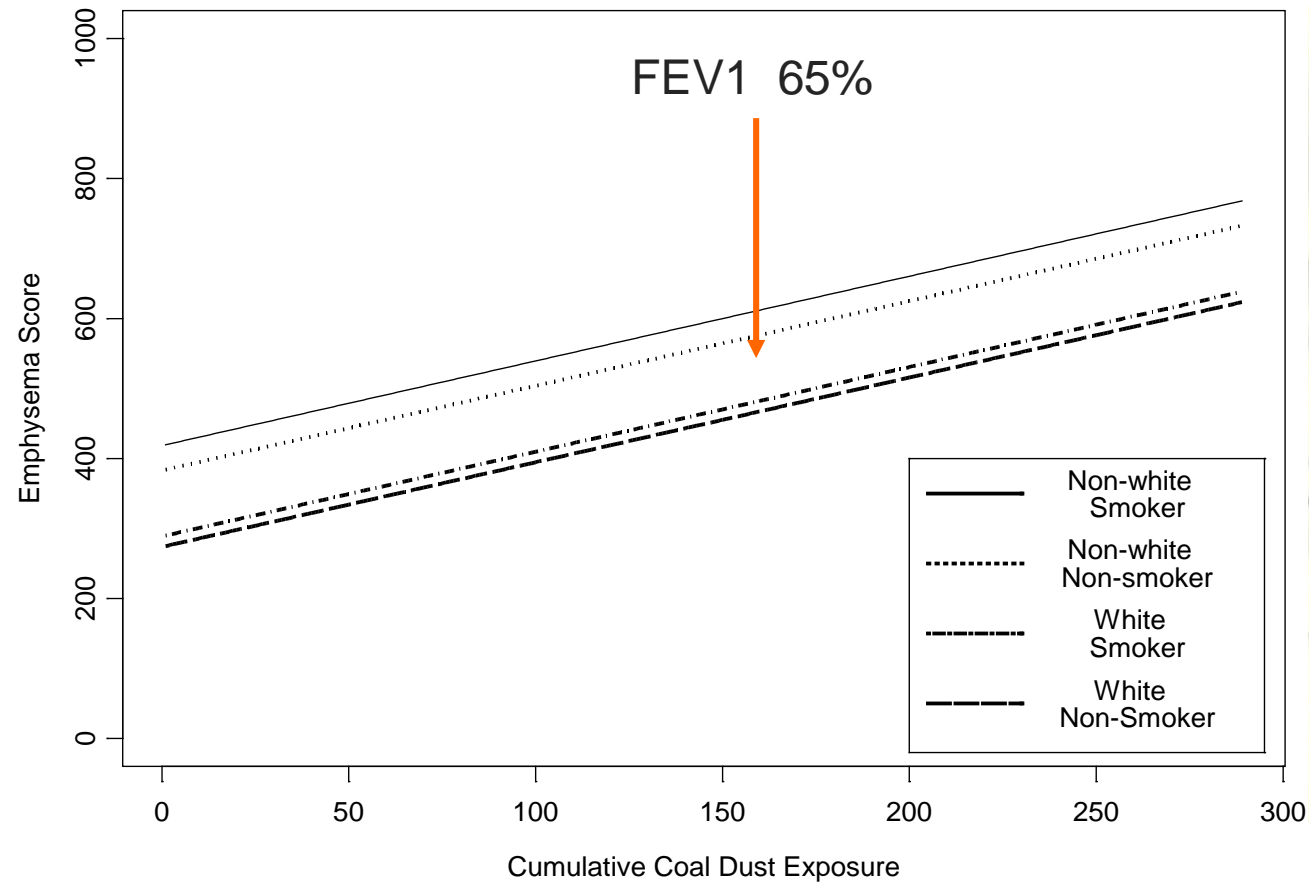
Severe panacinar emphysema



VL-71-12 (M)
FORMALIN FUMES
AIR DRIED



Cumulative Coal Mine Dust Exposure and Predicted Emphysema Index



NIOSH Study: Results

The Emphysema:

- All types of emphysema were more common in miners compared to non-miners (smokers and non-smokers)
- Centriacinar emphysema was the most common type for all groups (miners and non-miners, smokers and non-smokers)
- Scar and Bullous emphysema more common in miners compared to non-miners ($p < 0.01$)
- Emphysema more common in upper lung zones for all groups ($p < 0.01$)

Results (2)

Significant positive relationships were seen between emphysema score and:

- Years of underground mining
- Estimated cumulative dust exposure
- Retained lung dust ($p < 0.0001$)
- Radiographic category of pneumoconiosis ($p < 0.0001$)
- Pathologic type and severity of pneumoconiosis
- FEV_1 ($p < 0.001$)
- Cigarette smoking ($p < 0.006$)
- Race
- Age

Results (3)

- Smoking and coal mine dust
 - Contributed to the emphysema score independently
 - Their effects are additive
- Average lifetime dust exposure in this coal mining population contributed more to the emphysema score than average cigarette smoking.
- Equivalent effect on emphysema score of exposure to
 - Coal mine dust at 1 mg/m^3 for 1 year
 - Cigarette smoking of 1 pack/day for 1 year.

Other Key Points

- Emphysema can be difficult to see on a chest x-ray
- Emphysema can occur with or without identifiable CWP
- Lung function testing can help detect emphysema and other lung diseases that result from coal mine dust



Conclusions

- Emphysema is a condition where the lung develops holes where there used to be normal tissue
 - This causes significant damage to gas exchange
 - Loss of support to airways causing obstruction to air flow
- In the general population the most common cause is tobacco smoke exposure
- In coal mine workers, may also be caused by coal mine dust

Conclusions

- Coal mine dust causes all anatomic types of emphysema
- The biologic mechanisms (pathogenesis) of smoking induced and coal dust induced emphysema are identical
- The emphysema severity is significantly related to years of underground mining, estimated cumulative dust exposure and retained dust in the lungs
- Average lifetime exposure to dust contributed significantly more to the emphysema score than did average lifetime smoking
- Exposure to coal mine dust at a concentration of $1\text{mg}/\text{m}^3$ level for 1 year would contribute to the emphysema score the equivalent of smoking 1 pack/day of cigarettes for 1 year