Breathing is truly a strange phenomenon of life, caught midway between the conscious and unconscious and peculiarly sensitive to both.”

Dickenson Richards, M.D.
Columbia University College of Physicians and Surgeons
Nobel Laureate in Medicine, 1956

Roses are red,
Violets are blue;
Without your lungs,
Your blood would be, too

Goals and objectives for the pulmonary section: I
- Understand important categories and causes of lung disease in the United States and around the world
- Understand lung mechanics in health and disease
  - Lung mechanics (determination of efficiency of ventilation)
  - Compliance
  - Resistance
  - $P_a - P_{e} \over \text{flow}$
  - PEEP and Auto-PEEP

Goals and objectives for the pulmonary section: II
- Understand gas exchange in health and disease
  - Alveolar air equation and calculation of alveolar-arterial (A-a) gradient
  - $PAO_2 = \frac{IHO_2 - (PCO_2/R)}$
  - Oxygen delivery to tissues
  - $DO_2 = \text{CO} \times \text{CaO}_2$
  - Measuring alveolar hypoventilation
  - $\text{PEEP and Auto-PEEP}$

Goals and objectives for the pulmonary section: III
- Understand symptoms and signs of pulmonary disease
  - Symptoms
    - Dyspnea
  - Severity
  - Triggers
  - Progression
  - Signs
    - Wheezing
    - Crackles (rales and rhonchi)
    - Diminished breath sound
    - Hyperresonant breath sounds
- Understand use of diagnostic testing in pulmonary disease
  - Pulmonary function testing
  - Arterial blood gas analysis
  - Chest radiograph
  - Lung pathology
  - Major types and patterns of injury and abnormality

Goals and objectives for the pulmonary section: IV
- Understand treatment approaches to patients with lung diseases
  - Symptomatic treatments
  - Oxygen therapy
  - Bronchodilators
  - Mechanical ventilation and PEEP
  - Disease specific treatments
    - Steroids
    - Other immunosuppressives
    - Antibiotics
    - Anti-neoplastics
    - Pulmonary vasodilators
Leading causes of global mortality

Leading causes of death in the world

Impact of respiratory illness on global mortality

Global deaths due to acute respiratory infections

Yearly prevalence (in 000s) of acute respiratory infections (ARI), by WHO region

Deaths due to ARI, by WHO region
Deaths due to ARI, by age and sex, worldwide

Source: WHO Global Disease Burden Report

Cause of death among children less than 5 years of age

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Africa</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute respiratory infection</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Diarrheal disease</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Malaria</td>
<td>22</td>
<td>10</td>
</tr>
<tr>
<td>Measles</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>HIV or AIDS</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Neonatal deaths</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>Other causes</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td><strong>All causes</strong></td>
<td>4.5 million</td>
<td>10.9 million</td>
</tr>
</tbody>
</table>

Source: NEJM, WHO

Influenza

- Roughly 20% of children and 5% of adults develop symptomatic influenza infections each year
- Infection is continuous in tropics, seasonal elsewhere
- Three types of influenza virus: A, B, C
- Only types A and B cause outbreaks
- Two major surface proteins:
  - Hemagglutinin: facilitates entry into host cells through sialic acid receptors
  - Neuraminidase: catalyzes cleavage of glycosidic linkages to sialic acid and assists in release of progeny virions from infected cells; drug target
- Influenza A:
  - 15 hemagglutinin subtypes
  - 9 neuraminidase subtypes
- Influenza B
- Influenza C

Natural hosts of influenza viruses

At present, only H1N1 and H3N2 are in circulation among humans

Pandemic influenza

- Caused by sudden appearance of a new subtype: antigenic shift
- 1918–1919
  - H1N1: “Spanish flu”
  - Asian origin: 1.5 million deaths in first year; 50 million deaths total
- 1957–1958
  - H2N2: “Asian flu”
  - Asian origin: 70,000 deaths in U.S.
- 1968–1969
  - H3N2: “Hong Kong flu”
  - Asian origin: 34,000 deaths in the U.S.
- Future pandemics?
  - H5N1 (Avian flu)
  - H7N7

Both are highly lethal, though little if any person-to-person transmission yet documented
Strategies for controlling influenza

- Surveillance
- Vaccination
- Treatment

Leading causes of death in the U.S., 1980 and 2004

<table>
<thead>
<tr>
<th>Year</th>
<th>Cause</th>
<th>Year</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>Heart disease</td>
<td>2004</td>
<td>Heart disease</td>
</tr>
<tr>
<td>2.</td>
<td>Cancer</td>
<td>2.</td>
<td>Cancer</td>
</tr>
<tr>
<td>3.</td>
<td>Cerebrovascular disease</td>
<td>3.</td>
<td>Cerebrovascular disease</td>
</tr>
<tr>
<td>4.</td>
<td>Unintentional injuries</td>
<td>4.</td>
<td>COPD</td>
</tr>
<tr>
<td>5.</td>
<td>COPD</td>
<td>5.</td>
<td>Unintentional injuries</td>
</tr>
<tr>
<td>6.</td>
<td>Pneumonia and influenza</td>
<td>6.</td>
<td>Diabetes</td>
</tr>
<tr>
<td>7.</td>
<td>Diabetes</td>
<td>7.</td>
<td>Alzheimer's Disease</td>
</tr>
<tr>
<td>8.</td>
<td>Chronic liver disease</td>
<td>8.</td>
<td>Pneumonia and influenza</td>
</tr>
<tr>
<td>10.</td>
<td>Suicide</td>
<td>10.</td>
<td>Sepsis</td>
</tr>
</tbody>
</table>

Deaths due to pneumonia and influenza, U.S., by year and sex

Age-specific mortality for ARI, US, 2001

Source: National Center for Health Statistics
Risk factors for community acquired pneumonia

- Advancing age
- Tobacco use
- Air pollution
- Underlying chronic disease
- Malnutrition
- Alcohol use
- Chronic obstructive pulmonary disease
- Others including immunodeficiency, treatment with immunosuppressive drugs, malignancy, etc.

Pneumococcal vaccine coverage in persons > 65 years, U.S., 1997-2005

Influenza vaccine coverage, United States, 2004-2005

Influenza


2007 Estimated US Cancer Deaths*

Men Women
Lung & bronchus 289,550 270,100
Prostate 9% 15% 10% 6% 4% 4% 3% 3%
Colon & rectum 9% 6% 6% 6% 3% 3% 3% 3%
Pancreas 6% 6% 6% 6% 3% 3% 3% 3%
Leukemia 4% 4% 4% 4% 4% 4% 4% 4%
Liver & intrahepatic bile duct 4% 4% 4% 4% 4% 4% 4% 4%
Cervix 4% 4% 4% 4% 4% 4% 4% 4%
Brain/ONS 3% 3% 3% 3% 3% 3% 3% 3%
Kidney 3% 3% 3% 3% 3% 3% 3% 3%
All other sites 24% 24% 24% 24% 24% 24% 24% 24%

*2007: other sites include all solid cancers except colon, breast, leukemia, and lymphoma

Source: American Cancer Society

Global tobacco-related mortality, 2002-2030

Source: Mathers and Loncar, PLOS 2006; 3: e442

Tobacco-related deaths annually, U.S.

Source: CDC, ALA

Smoking trends, United States, 1965-2006

Source: MMWR 2007; 56: 1157-1161

Percentage of High School Students Who Reported Lifetime Cigarette Use,* by Sex** and Race/Ethnicity, 2005

Source: National Youth Risk Behavior Survey, 2005
National Youth Risk Behavior Survey, 2005

Percentage of High School Students Who Reported Current Cigarette Use,* by Sex and Race/Ethnicity,** 2005

Limiting morbidity and mortality from tobacco use

- Medical model
  - Smoking cessation
  - Early detection and treatment of smoking related illness:
    - Lung cancer screening
    - Prevention and treatment of COPD

- Public health model
  - Limiting access to tobacco
  - Raising cigarette tax
  - Enforcing age limits for purchase
  - Smoking restrictions in workplaces and public facilities
  - Discouraging use of tobacco
    - School-based initiatives
    - Counter advertising

Hutchinson Smoking Prevention Project: Long-Term Randomized Trial of School-Based Tobacco Use Prevention

- 40 school districts in Washington State randomized to provide comprehensive anti-tobacco curriculum (based on CDC and NCI recommendations) in grades 3-12 or standard health curriculum
- Main study endpoints were smoking in grade 12 and 2 years after high school
- 8388 students entering third grade were subjects in the study; follow-up data available on 93%
- Prevalence of daily smoking at study conclusion: 24.66% in control districts, 24.41% in experimental districts


* Smoked cigarettes on ≥ 1 of the 30 days preceding the survey
** W, H > B


FIGURE 10: SUCCESS RATES FOR VARIOUS CESSATION METHODS, 1998

Source: CDC Office on Smoking & Health – Cessation Division

Percentage of success (EG= example group, PG= placebo group)

- Self-help only: 4.0%
- Patch: 8.0%
- Gum: 14.0%
- Behavioral: 15.0%
- Nicotine: 19.0%
- Figure 10: 27.5%
- Prescriptions: 28.0%
- Heat lamps: 30.0%
Smoke-Free Workplace Act of 2002 (NYC Local Law 47)

- Law took effect March 30, 2003
- Bans smoking in all indoor workplaces in New York City, including bars and restaurants of any size.
- Exemptions for 7 currently existing cigar bars.
- Exemptions for owner operated bars.
- Restaurants will be allowed to build completely enclosed, negative pressure ventilated smoking rooms into which no employee will be allowed until the last customer of the day has left. Clause sunsets after three years.
- New York State has adopted a similar law that covers the entire state.
Workplace smoking ban, Ireland

From McElvaney N.G. NEJM 2004; 2231-2234