University of Kentucky

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CPH601 Chapter 10 Industrial Pollution and Chemical Safety

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Industrial Pollution and Chemical Safety and Occupational Health

David Mannino, M.D.
Overview

- Industrial Sources of Pollutants
- Industry-Specific Hazards
- Major Contaminants of Concern
- Occupational Safety and Health
- Catastrophes
- Approach to Prevention
BOX 10.1
Industrial Pollution Emissions and Resource Requirements as Proportion of Overall Emissions and Resource Requirements

In the countries of the Organization for Economic Cooperation and Development (OECD), industrial output represents around one-third of the aggregate gross national product (GNP). The pollution emissions or resource requirements of industry in 1987 were the following:

15% of water consumption (excluding water used for cooling)
25% of nitrogen oxide emissions
36% of final energy use
40%–50% of sulfur oxide emissions
50% of contributions to the greenhouse effect
60% of biological oxygen demand and substances in suspension
75% of noninert waste (infectious, toxic, or radioactive waste)
90% of toxic substances discharged into water.

Public Exposure from Industrial Sources

- Air
- Water
- Hazardous Wastes and Chemical Contamination
Industrial Air Pollutants

- Sulfur Oxides
  - fossil fuel burning
- Nitrogen Oxides
- Particulate Matters
- VOCs
  - combustion of fossil fuels, use of solvents, & industrial processes
- POPs
- CO$_2$
Air Pollution “Control”

- Choose location
  - Wind direction, distance to community, geographical features
- Taller Stacks
  - Decrease local pollution but disperse over a wider area
- Cleaner fuels
  - Lower sulfur fuels decrease sulfur oxides
- Energy efficiency
  - Increasing the efficiency of combustion
- Scrubbers
  - Remove particulate matter from the stack, but removed pollution needs to be stored
Industrial Water Pollution

- Pulp Mills
- Power plants
- CAFOs
- Ground Water Pollution
  - Leaking storage tanks

- Clean Water Act has greatly decreased water pollutant exposure in the US
Industrial Water Pollution

- Pathogens
  - CAFOs
- Arsenic
  - Ore-smelting operations
- Mercury
  - Chloralkali plants, leaking landfills, combustion of coal
- PCBs (Polychlorinated biphenyls)
- PBEDs (Polybrominated Diphenyl Ethers)
  - flame retardants
Water Pollution “Control”

- **Treatment-Based Approaches**
  - Wastewater Treatment (sanitary sewage treatment)
  - E.g. Steel Mill Wastewater Treatment (removal of soluble metals)
    - Wastewater segregation; Equalization; Reaction mixing; Chemical treatment; Clarification; Final pH adjustment and filtration; and then Flow reduction and water conservation.

- **Exposure Reduction**
  - Beach advisory
  - Drinking Water Treatment & reservoir protection

- **Source Control/Prevention**
  - Recycling and reuse of industrial waste
  - Organic farming practices
Biodegradation

- A process by which microbial organisms transform or alter (through metabolic or enzymatic action) the structure of chemicals introduced into the environment.
Bioaccumulation and Biomagnification of PCBs

Zooplankton 0.123 ppm
Phytoplankton 0.025 ppm
Smelt 1.04 ppm
Lake Trout 4.83 ppm
Herring Gull Eggs 1.24 ppm
Hazardous Wastes/Chemicals

- Discarded solid or liquid material that may, directly or indirectly, cause adverse health effects, unless properly treated, stored, or disposed in a manner that meets specific governmental regulatory definitions.

- A waste may be classified as hazardous if it meets one of the following four characteristics:
  - Ignitability: flashpoint at or less than 140°F
  - Corrosivity: pH ≤ 2 or ≥ 12.5
  - Reactivity: potential to explode or give off highly toxic gases
  - Toxicity: capability of poisoning life forms
Hazardous Wastes/Chemicals

- Solvents
  - chlorinated compounds, e.g. benzene and trichlorethylene waste sites
- Paints and coatings
- Metals
- PCBs
  - Persistent Organic Pollutants (POPs)
- Pesticides
  - organophosphates
- Acids and alkalis
  - nitric acid and hydrofluoric acid
Hazardous Wastes/Chemicals

- Covered by Several Federal Laws (see Chapter 8 in Information Guide)
- Resource Conservation and Recovery Act (RCRA 1976)
  - Hazardous Waste Disposal (Cradle to Grave)
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA-Superfund 1980)
  - Clean-up of Hazardous Waste Sites
- Superfund Reauthorization Act (SARA - 1986)
Hazards by Industry

- Materials Extraction
- Processing
- Manufacturing
- Service
Materials Extraction/primary industry

- Minerals/Fossil Fuels
  - Physical damage to environment, mine collapses, fires, radiation exposure

- Forestry
  - Erosion, trauma

- Agriculture (Chapter 7)
  - Chemical exposure, dusts, equipment

- Fishing
  - Overexploitation: damage to ecosystem, losing valuable food sources
Processing Industries

- **Metal processing**
  - Air, water, land pollution; toxic chemicals

- **Petrochemical processing**
  - Air and water pollution, solvents (e.g. benzene), fire risks

- **Pulp and paper mills**
  - Water usage, lignin (increase BOD), fungicides, air pollution (odors, dusts), chlorine

- **Food processing**
  - Water pollution, injuries
Manufacturing

- Use of raw materials to create consumer products
  - Chemical exposures
  - Dust exposure (cotton)
  - Repetitive motion injuries (Assembly lines)
  - Solvent exposure
Service

- Tourism, Health Care, Restaurant, entertainment, etc.
- Less “traditional” pollution
  - Increased sanitation pressures
  - Medical Wastes
  - Noise
  - Ergonomic issues
  - Stress
Major Contaminants of Concern

- Lead
- Mercury
- Arsenic
- Solvents (benzene, styrene)
Lead: Environmental Exposure

- Household paint (<1978)
- Lead mining
- Lead smelting
- Car battery production
- Bridge construction
- Lead in gasoline (<1995)
  - Leaded gas in 17 countries
- Water – residential (<1985)
- Soil
- Toys
- Jewelry
- Lead-glazed pottery
- Home remedies/medications
- Cosmetics
- Fruits/vegetables
Lead: Routes of exposure

**Ingestion**
- Paint chips (children)
  - Lead based painted walls
  - Toys/pottery/jewelry
- Lead dust
  - Floors of homes (children)
  - Hands/clothes into mouth (all)
- Food (contaminated soil)
- Water (old pipes)

**Inhalation**
- Gas fumes (international)
- Lead dust
  - Lead mining
  - Lead smelting
  - Auto shops
  - Bridge construction
Lead: Biology Fate

**Distribution**

- Shortly after lead gets into your body, it travels in the blood to the “soft tissues” and organs
  - Liver, kidneys, lungs, brain, spleen, muscles, and heart
- After several weeks, most of the lead moves into bones and teeth
  - 94% of lead in adults
  - 73% of lead in children
  - Some stay for decades
  - Some reenter blood and organs (e.g. during pregnancy and periods of breast feeding, after a bone is broken, during advancing age)

**Excretion**

- Human body does not change lead into any other form
- 99% of intake (adult) will leave the body in urine or feces within a couple of weeks
- Only 32% of intake (children) will leave the body
- Continued exposure may result in accumulation of lead in body tissues, especially bone
Lead: Adverse Health Effects

**Adults**
- Acute: uncommon
- Chronic
  - Accumulates in bone for years
  - Affects all body systems
  - Neurologic, gastrointestinal, fertility, renal failure, hypertension, hearing loss, arthralgia, anemia

**Children**
- Acute: uncommon
- Chronic
  - More vulnerable: rapid period of brain development
  - Neurological deficits:
    - Learning disabilities
    - Behavioral problems
    - Hearing loss
    - Decreased attention span
    - **Mental retardation**
Lead: Public Health Interventions

**Primary prevention**
- Federal ban on lead in gasoline (1973 – 1995)
- Federal ban on lead in paint (1978)
- Federal ban on lead in children’s toys (2008)
- Federal law controlling renovation methods in high risk residential areas
- CDC: working on initiatives to ban lead in jewelry and cosmetics

**Secondary prevention**
- Mandated state screening of children <2 years old
- Therapy: focused on reduction of continued lead exposure
- CDC: more resources for high risk areas (environmental injustice)

The reduction of blood lead levels in the U.S. (1970-2003) was one of the most significant public health successes of the last half of the 20th century.
Arsenic: Background & Significance

- Known and used since ancient times as poison
- Also used by physicians to treat leukemia
- A classic example of Paracelsus’ dictum of “The dose makes the Poison”
- Industrial uses include:
  - Hardening of bronze
  - Wood preservation
  - Making of gallium arsenide
  - Microchip industry
  - Lead-acid batteries for automobiles
Arsenic in Nature

- Arsenic is abundant in nature. Present in:
  - Air (urban) – 20 to 30 ng/m3
  - Continental crustal rocks – 2100 ppb
  - Soil – average level of 3-4ppm
  - Sea water - 2.3 ppb
  - Surface water - 1 ppb
  - Food – 20 to 140 ppb (organic form - arsenobetaine)
  - Human body - 50 ppb
  - The body of a 75 kg adult contains about 0.004 grams of Arsenic
Known Arsenic Hazards

- **Ingestion of high doses** (60,000 ppb in water, 10,000 times higher than 80% of U.S. drinking water arsenic levels) - death
- **Ingestion of low doses of arsenic** (300 to 30,000 ppb in water, 100 to 10,000 times higher than most U.S. drinking water levels) - gastroenteritis
- Causes dark skin patches and warts
  - long term oral exposure
  - may also skin cancer
- **Interferes with hematopoiesis**
  - decreased production of red and white blood cells
- **An indirect carcinogen**
  - linked to cancers of the liver, bladder and lungs
  - Inorganic arsenic is a human carcinogen (DHHS & EPA)
- **Anemia in pregnancy**
- **Low birth weight, fetal malformations, and even fetal death** (animal studies)
Arsenic: Biologic Fate

- **Absorption:**
  - GI tract – about 95% of soluble trivalent As compounds
  - Lung – about 60% to 90%
  - Dermal – negligible

- **Distribution (2 – 4 weeks after exposure):**
  - keratin-rich tissues: hair, nail, skin, etc.

- **Metabolism**
  - Red blood cells, white blood cells, and some other cells: reduce As(V) to As(III)
  - Liver: As(III) methylation (detoxification)

- **Excretion**
  - Urine (primary): about 50% dimethylated, about 25% monomethylated, the remainder being inorganic
  - Others: feces, hairs and nails, skin desquamation, and sweat
Major Environmental Arsenic Incidents

- About 20 incidents reported worldwide
- Four most serious incidents are:
  - Groundwater arsenic contamination in Bangladesh;
  - West Bengal, India;
  - Inner Mongolia, China;
  - Taiwan
Arsenic: Public Health Interventions

- EPA has set limits on the amount of arsenic that industrial sources can release into the environment.
- EPA has restricted or canceled many of the uses of arsenic in pesticides and is considering further restrictions.
- In January 2001, EPA lowered the limit for arsenic in drinking water to 10 ppb.
- OSHA has established a permissible exposure limit in various workplaces that use inorganic arsenic.
Mercury: Background

- Mercury toxicity has been dated back to 1500 BC
- Mercury occurs naturally in the air, soil, and water.
  - Also in some products (batteries & thermometers)
- Methylmercury: fish and shellfish.
  - Majority of mercury problems in the U.S.
- Elemental Mercury: occupational hazard.
  - Dental amalgams
- Minamata Disease 1960: Large consumption of fish and shellfish coming from Minamata Bay (Japan) produced this disease.
  - Mercury was released into the water from a chemical factory.
Mercury: Biologic Fate

Exposure Route
- Oral – virtually none absorption of metallic mercury, generally less than 10% of inorganic mercury salt, about 95% of Methyl-mercury
- Lung – about 80% of metallic mercury
- Skin – Dimethylmercury (but not methylmercury) can rapidly enter the body through skin

Distribution
- Metallic: brain (readily converted to an inorganic form and “trapped” in the brain for a long time) and kidneys; can enter developing child
- Inorganic: moves to many different tissues, mostly in the kidneys and not as easily to enter brain
- Organic: move easily to most tissues and readily enters the brain; easily transport from mom to child; be converted to an inorganic form and “trapped” in the brain for a long time

Excretion
- Metallic: most eventually leaves in the urine and feces, smaller amount leave in the exhaled breath
- Inorganic: leaves in the urine or feces over several weeks or months; a small amount can be changed to metallic form and leave in the breath as a mercury vapor; some present in breast milk
- Organic: leaves slowly over a period of several months, mostly as inorganic mercury in the feces
Mercury: Exposure and Risk Assessment

- **Exposure:**
  - Pregnant women and children are most susceptible to Methylmercury poisoning.
  - For adults: a relatively safe mercury concentration is normally less than 1.5 micrograms per deciliter (µg/dL) of blood.
  - A level greater than 5 µg/dL is considered to be toxic.

- **Risk Assessment:**
  - **Mercury Maps:** provide each state and EPA region with the tools to examine changes in mercury air deposition rates to changes in mercury fish tissue concentrations.
  - **Toxic Exposure Surveillance System:** produces statistics based on the number of exposures, severity of exposure, and age of individuals most susceptible.
Mercury: Toxicity and Prevention/Controlling

- **Toxicity:**
  - Mercury transforms into toxic Methylmercury from bacteria in the water.
  - Larger fish will have more Methylmercury due to consumption of its smaller prey.

- **Prevention/Controlling:**
  - Follow dietary guidelines set for mercury levels in fish and shellfish
  - Properly dispose mercury containing products
    - Ex: florescent lamps & thermometers
  - U.S has placed mercury bans for certain products
### Why Do Your Seafood Choices Matter?

Worldwide, the demand for seafood is increasing. Yet many populations of the large fish we enjoy eating are overfished and, in the U.S., we import over 90% of our seafood to meet the demand. Destructive fishing practices can add to the problem.

By purchasing fish caught or farmed using environmentally friendly practices, you’re supporting healthy, abundant oceans.

### You Can Make a Difference

Support ocean-friendly seafood in three easy steps:

1. Purchase seafood from the ocean list or, if unavailable, the yellow list. Or look for the Marine Stewardship Council blue eco-label in stores and restaurants.
2. When you buy seafood, ask where your seafood comes from and whether it was farmed or wild-caught.
3. Tell your friends about Seafood Watch. The more people that ask for ocean-friendly seafood, the better!

### Learn More

In addition to the recommendations on this guide, we have hundreds more available from our scientists.

To see the complete and most up-to-date list visit us:
- Online at seafoodwatch.org
- On our free app
- On our mobile site
- Or join us on Facebook or Twitter

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### BEST CHOICES

- Arctic Char (farmed)
- Barramundi (US farmed)
- Catfish (US farmed)
- Clams, Mussels, Oysters (farmed)
- Cod: Pacific (US non-trawled)
- Crab: Dungeness, Stone Halibut: Pacific (US)
- Lobster: California Spiny (US)
- Perch: Yellow (Lake Erie)*
- Sablefish/Black Cod (Alaska & Canada)
- Salmon (Alaska wild)
- Sardines: Pacific (US)
- Scallops (farmed)
- Shrimp: Pink (Oregon)
- Striped Bass (farmed & wild)*
- Tilapia (US farmed)
- Trout: Rainbow (US farmed)
- Tuna: Albacore (Canada & US Pacific, troll/pole)
- Tuna: Skipjack, Yellowfin (US troll/pole)
- Whitefish: Lake (Lake Huron & Superior)*
- Whitefish: Lake (Lake Michigan, trap-net)*

### GOOD ALTERNATIVES

- Basa/Pangasius/Swai (farmed)
- Caviar, Sturgeon (US farmed)
- Clams, Oysters (wild)
- Cod: Pacific (US trawled)
- Crab: Blue*, King (US), Snow
- Flounders, Soles (Pacific)
- Flounder: Summer (US Atlantic)
- Groupers: Black, Red (US Gulf of Mexico)*
- Herring: Atlantic, Lake
- Lobster: American/Maine
- Mahi Mahi (US)
- Perch: Yellow (Lake Ontario & Huron)
- Pollock: Alaska (US)
- Salmon (CA, OR, WA*, wild)
- Scallops (wild)
- Shrimp (US, Canada)
- Smelt: Rainbow
- Swordfish (US)*
- Tilapia (Central & South America farmed)
- Trout: Lake (Lake Huron & Superior)*
- Tuna: Bigeye, Tongo, Yellowfin (troll/pole)
- Walleye* Whitefish: Lake (Lake Michigan, gillnet)*

### AVOID

- Caviar, Sturgeon* (imported wild)
- Chilean Seabass/Toothfish*
- Cod: Atlantic (Canada & US)
- Crab: King (imported)
- Flounders, Halibut, Soles (US Atlantic, except Summer Flounder)
- Groupers (US Atlantic)*
- Lobster: Spiny (Brazil)
- Mahi Mahi (imported longline)
- Monkfish
- Orange Roughy*
- Salmon (farmed, including Atlantic)*
- Sharks*
- Shrimp (imported)
- Snapper: Red
- Swordfish (imported)*
- Tilapia (Asia farmed)
- Trout: Lake (Lake Michigan)*
- Tuna: Albacore*, Bigeye*, Skipjack, Tongo, Yellowfin* (except troll/pole)
- Tuna: Bluefin
- Tuna: Canned (except troll/pole)

### Support Ocean-Friendly Seafood

**Best Choices** are abundant, well-managed and caught or farmed in environmentally friendly ways.

**Good Alternatives** are an option, but there are concerns with how they’re caught or farmed—or with the health of their habitat due to other human impacts.

**Avoid** for now as these items are overfished or caught or farmed in ways that harm other marine life or the environment.

**Key**

- CA = California
- OR = Oregon
- WA = Washington

Limit consumption due to concerns about mercury or other contaminants. Visit [www.edf.org/seafoodhealth](http://www.edf.org/seafoodhealth)

Contaminant information provided by: [ENVIRONMENTAL DEFENSE FUND](http://www.edf.org/seafoodhealth)

Seabed may appear in more than one column.
How *Mercury* Relates Today:

- Mercury exposure and contamination will continue to be a problem due to its natural presence.

- Individuals are more aware of mercury due to agencies disseminating information (EPA, FDA, CDC etc.).

- Even with recent findings, other countries still have less stringent regulations on mercury in products.
Benzene: background

- Isolated in 1836 from coal tar
- Used in industry processes
  - Rubber, shoes, polyvinyl chloride, petroleum, plastics
- Present in combustible materials
- Who is at risk
  - Firefighters
  - Industry Workers
  - Smokers
  - YOU!
Benzene: Safe exposure levels

- **OSHA**
  - <1 ppm for 40-hour work week in 8-hour shifts

- **EPA**
  - <5 ppb in water
  - Spills <10 lbs
Benzene: Mechanism of toxicity

- **Manifestations**
  - Dizziness, confusion, hallucinations (and other neurologic symptoms)
  - Skin irritation
  - Renal failure
  - Arrhythmias
  - Leukemia (and other cancers)
  - CNS Depression
  - Death
  - ... and more

- **Routes**
  - Oral inhalation
  - Gastrointestinal absorption
  - Skin absorption
Benzene: Prevention and Control

- **Everyone**
  - Avoid smoky areas
  - Limit time spent in traffic
  - **NO SMOKING!**

- **Occupational**
  - Face masks
  - Gloves
  - Ventilated Hoods
Other major chemical contaminants of concern

- Cadmium
  - Used as an anti-corrosive coating on steel, and in rechargeable electric batteries
  - Accumulates in the liver and kidneys
  - Health effects usually develop after many years of exposure
  - “Itai-itai” disease

- Solvents
  - Cleaners, degreasing agents, extraction solvents, viscosity modifiers, constituents of glues and paints, paint or coating removers
  - Most solvents evaporate easily and therefore easily inhaled in the workplace
  - Many solvents are highly toxic to liver
  - “Painter’s syndrome”

- Bulk Raw Materials
  - Accidental release of large quantity of hazardous materials, such as chlorine gas, flammable liquids and gases, cyanides, etc.
Occupational Safety and Health

- Maintaining worker health is good for business!
  - Conflicts between cost of safer worksite practices and cost to society/worker

- Worker’s Compensation
  - Work well for injuries- less well for diseases

- Increasing role of Women in the workplace
  - In addition to traditional social roles
  - Many low-wage women workers are single mothers
Number and rate of fatal occupational injuries, by industry sector, 2008

The highest number of fatal work injuries in 2008 occurred in the private construction sector, followed by transportation and warehousing. However, the highest fatal work injury rates were in the agriculture, forestry, fishing, and hunting sector and the mining sector. Both of these sectors recorded a fatality rate that was more than 4 times higher than the rate of 3.7 recorded for all workers.

In 2008, the Bureau implemented a new methodology, using hours worked, rather than employment, for fatal work injury rate calculations. Rates are expressed per 100,000 full-time equivalent workers. Additional information on changes in the fatal work injury rate methodology is found on the internet at [http://www.bls.gov/If/oshnotice10.htm](http://www.bls.gov/If/oshnotice10.htm).

Three sectors alone—manufacturing, health care and social assistance, and retail trade—combined to account for about half of recordable cases reported among all private industry establishments in 2008.

The rate of nonfatal injuries and illnesses among private industry sectors in 2008 ranged from 5.7 cases per 100 workers in transportation and warehousing down to 0.9 case in finance and insurance. Manufacturing had the highest number of nonfatal cases, 689,700.

**Incidence rate and number of nonfatal occupational injuries and illnesses, by private industry sector, 2008**

- **Industry sector**
  - Transportation and warehousing (241.8 cases, 660.2 thousand cases)
  - Health care and social assistance (46.5 cases, 322.7 thousand cases)
  - Agriculture, forestry, fishing, and hunting (68.7 cases, 689.7 thousand cases)
  - Arts, entertainment, and recreation (311.7 cases, 532.8 thousand cases)
  - Manufacturing (218.5 cases, 514.3 thousand cases)
  - Construction (19.6 cases, 154.0 thousand cases)
  - Retail trade (19.6 cases, 154.0 thousand cases)
  - Accommodation and food services (19.6 cases, 154.0 thousand cases)
  - Wholesale trade (19.6 cases, 154.0 thousand cases)
  - Utilities (19.6 cases, 154.0 thousand cases)
  - Administrative and waste services (19.6 cases, 154.0 thousand cases)
  - Other services (except public administration) (19.6 cases, 154.0 thousand cases)
  - Real estate and rental and leasing (19.6 cases, 154.0 thousand cases)
  - Mining (19.6 cases, 154.0 thousand cases)
  - Educational services (19.6 cases, 154.0 thousand cases)
  - Information (19.6 cases, 154.0 thousand cases)
  - Management of companies and enterprises (19.6 cases, 154.0 thousand cases)
  - Professional and technical services (19.6 cases, 154.0 thousand cases)
  - Finance and insurance (19.6 cases, 154.0 thousand cases)

Occupational Hazards

- Chemical
  - Greater exposures of toxic metals, solvents, bulk raw materials

- Physical
  - Noise (most wide-spread); hot and cold environments; ionizing radiation

- Mechanical
  - Unsafe working conditions & ergonomic hazards

- Biological
  - Health care and agriculture industries

- Psychosocial
Occupational Diseases

- Respiratory Disease
- Skin Disorders
- Hearing Impairment
- Back and Joint Symptoms
- Cancer
- Exacerbation of Coronary Artery Disease Symptoms
- Liver Disease
- Neuropsychiatric Problems
- Illnesses of Unknown Cause
Important Respiratory Occupational Diseases

- **Occupational Asthma**
  - The most common form of occupational lung disease
  - Estimates suggest that 15 to 23 percent of new asthma cases in adults are work related (NIOSH, 2004)

- **Hypersensitivity Pneumonitis (HSP)**
  - Results from organic materials, commonly fungi or thermophilic bacteria
  - aka *extrinsic allergic alveolitis*
  - E.g. farmer’s lung

- **Byssinosis and other diseases caused by organic dusts**
  - *Brown lung*
  - Associated with exposure to cotton, hemp, and flax processing

- **Chronic Respiratory Tract Responses**
  - *Pneumoconiosis*: usually due to an inorganic dust or coal that of respirable size
  - *Silica-Related Disease*: exposure occurs in mining, quarrying and stone cutting, ceramics and vitreous enameling, in use of fillers for paints and rubber
  - *Emphysema*: chronic coal dust or cadmium exposure, long-term tobacco smoking
  - *Coal Workers’ Pneumoconiosis (CWP)*: induced by both coal dust and pure carbon
  - *Asbestosis*: sometimes, circumscribed pleural fibrosis (*pleural plaques*) are the only evidence of exposure

**Table 1** Exposure, disease process, and prevalence of occupational lung diseases (1)

<table>
<thead>
<tr>
<th>Occupational exposure</th>
<th>disease</th>
<th>Prevalence in exposed population</th>
<th>Time of exposure to onset of symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica</td>
<td>Acute Silicosis</td>
<td>Unknown</td>
<td>&lt; 1 year</td>
</tr>
<tr>
<td></td>
<td>Accelerated Silicosis</td>
<td>Unknown</td>
<td>3–10 years</td>
</tr>
<tr>
<td></td>
<td>Chronic or Classic Silicosis</td>
<td>12.8 percent</td>
<td>Decades</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Asbestosis</td>
<td>10–92 percent</td>
<td>Years</td>
</tr>
<tr>
<td></td>
<td>Benign Asbestos Pleural Effusion</td>
<td>3 percent</td>
<td>&lt; 20 years</td>
</tr>
<tr>
<td></td>
<td>Pleural Plaques</td>
<td>6–70 percent</td>
<td>Years</td>
</tr>
<tr>
<td>Coal</td>
<td>Simple Coal Workers’ Pneumoconiosis</td>
<td>5 percent</td>
<td>Years to decades</td>
</tr>
<tr>
<td></td>
<td>Complicated Coal Workers’ Pneumoconiosis</td>
<td>Unknown</td>
<td>Years to decades</td>
</tr>
<tr>
<td>Numerous (see Table 3)</td>
<td>Hypersensitivity Pneumonitis</td>
<td>12–20 percent</td>
<td>Day of exposure</td>
</tr>
</tbody>
</table>

**Table 2** Occupational lung disease and its workforce exposure

<table>
<thead>
<tr>
<th>Occupational lung disease</th>
<th>Exposed workforces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicosis</td>
<td>Sandblasters, miners, tunnelers, millers, potters, glassmakers, foundry and quarry workers, abrasive workers (including dental workers), silica flour mixers, and construction workers</td>
</tr>
</tbody>
</table>
| Asbestos                  | **Primary:** Miners, millers  
**Secondary:** Asbestos insulators (lagger), ship building and repair, boilermakers, fireproofing, brake liniers, ceramics workers  
**Indirect:** Electricians, plumbers, carpenters |
| Coal                      | Coal miners        |

Asthma in the Workplace

- **Occupational Asthma**
  - The “classic” form of asthma in the workplace related to sensitizing agents

- **Work-related asthma**
  - The “new” definition that encompasses any person whose asthma develops or worsens because of workplace exposures
  - Can be related to a variety of agents or irritants (cleaning fluids, copying machines, smoke)
Figure 1. Specific occupational challenge at the patient’s workplace using spray paints containing HDI. (This was done with informed consent as part of a research protocol for occupational asthma.)
Occupational Cadmium Exposure and Emphysema

Davison et al, Lancet 1988
Trends in Occupational Dust Related Mortality Over Time
Death from CWP
Silicosis – Different Presentations

- Acute Silicosis (months of exposure)
  - Acute silicoproteinosis
- Accelerated Silicosis (5-15 years exposure)
- Classic Silicosis
- Complications
  - Tuberculosis
  - Cancer?
Asbestos

CRÒCIDOLITE

AMOSITE

ANTHRIFLYLITE

CHRYSOTILE

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Asbestos Exposure

- Mining/manufacturing
- Insulation workers
- Pipefitters
- Shipyard workers
- Friction products
- Demolition workers?

Needle-like asbestos particles penetrate the lung and cannot be dissolved or destroyed by the body. Instead, the body coats them with a protein associated with iron. The presence of asbestos bodies in the lungs only signifies exposure, not disease.
Smoking, Asbestos Exposure, and Lung Cancer

Risk of Developing Lung Cancer

- Never Smoker/No Exposure
- Never Smoker/Yes Exposure
- Ever Smoker/No Exposure
- Ever Smoker/Yes Exposure

Selikoff et al
Hypersensitivity Pneumonitis Sources

- Thermoactinomyces spores
- Avian Proteins
- Rat Proteins
- Aspergillus
- Isocyanates or anhydrides
- Farmer’s Lung
- Pigeon Breeder’s Lung
- Lab Worker’s Lung
- Malt worker’s Lung
- Chemical Worker’s Lung
Popcorn Workers Lung

Catastrophes/Outbreaks

- Cadmium in Rice (Itai-Itai) – Japan 1950’s
- Methylmercury in Water – Minamata, Japan 1950’s
- Toxic Oil - Madrid, Spain – 1981
- Dioxin - Times Beach Missouri - 1983
- Methylisocyanate – Bhopal – 1984
- Multiple Pollutants - 9/11 attacks
Itai-Itai
Minamata

areas with outbreak of Minamata disease

source: "Our Intensive Efforts to Overcome the Tragic History of Minamata Disease 1999", Environmental Health Department, Environment Agency

The Areas Where patients were found

[Map showing areas affected by Minamata disease]
Love Canal
Toxic Oil

Frequency of Major Events in TOS

- Acute Lung disease: 70.0
- Sclerodermiform changes: 21.3
- Neuropathy: 32.0
- Pulmonary Hypertension: 8.2
- Liver disease: 7.2
- Sicca Syndrome: 35.0
- Eosinophilia: 78.0
- Myalgias: 80.0

Rate of Toxic Oil Syndrome Cases by Province

Number of cases per 100,000

- >290
- 211-290
- 141-210
- 140-71
- 1-71
- no
Times Beach
Bhopal
Post 9/11
Approaches to Prevention

1. Substitution of raw materials
2. Containment of dangerous processes
3. Reduce hazard levels
4. PPE
5. Worker training
6. Workplace monitoring