*CWPA Proceedings, 2001, pp 294-324*


# Arsenic and Old Lumber:

# A Medical Toxicologist's Perspective

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# Chemistry 101

- **Metalloid**
- **MW: 74.9**
- **Bonds with carbon, hydrogen and oxygen (hmmm…)**

# Chemistry 102

- Inorganic, organic
- Arsine (gaseous form)
- 3 most common valence states:
  - Elemental (0)
  - Arsenite (trivalent, +3)
  - Arsenate (pentavalent, +5)

# Sources of Arsenic

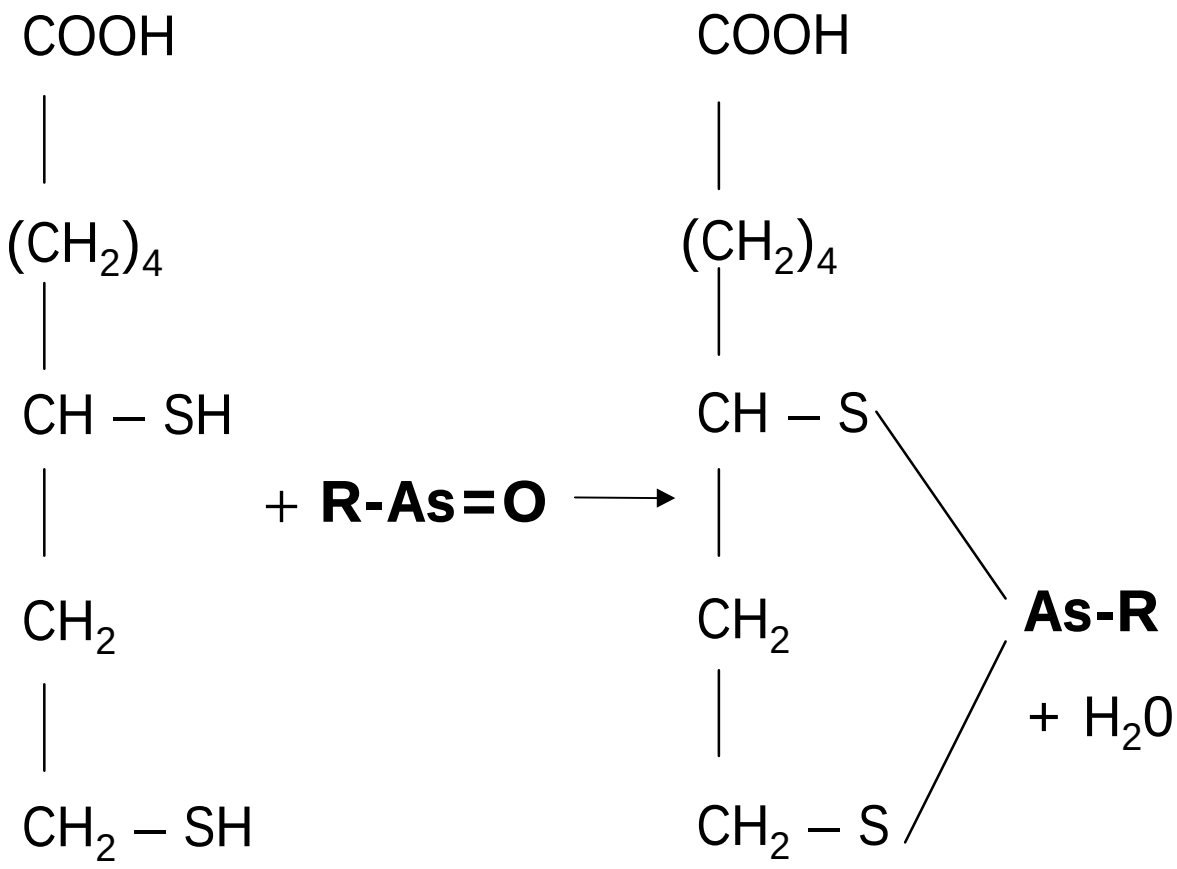
- Natural sources
  - Ore
  - Groundwater

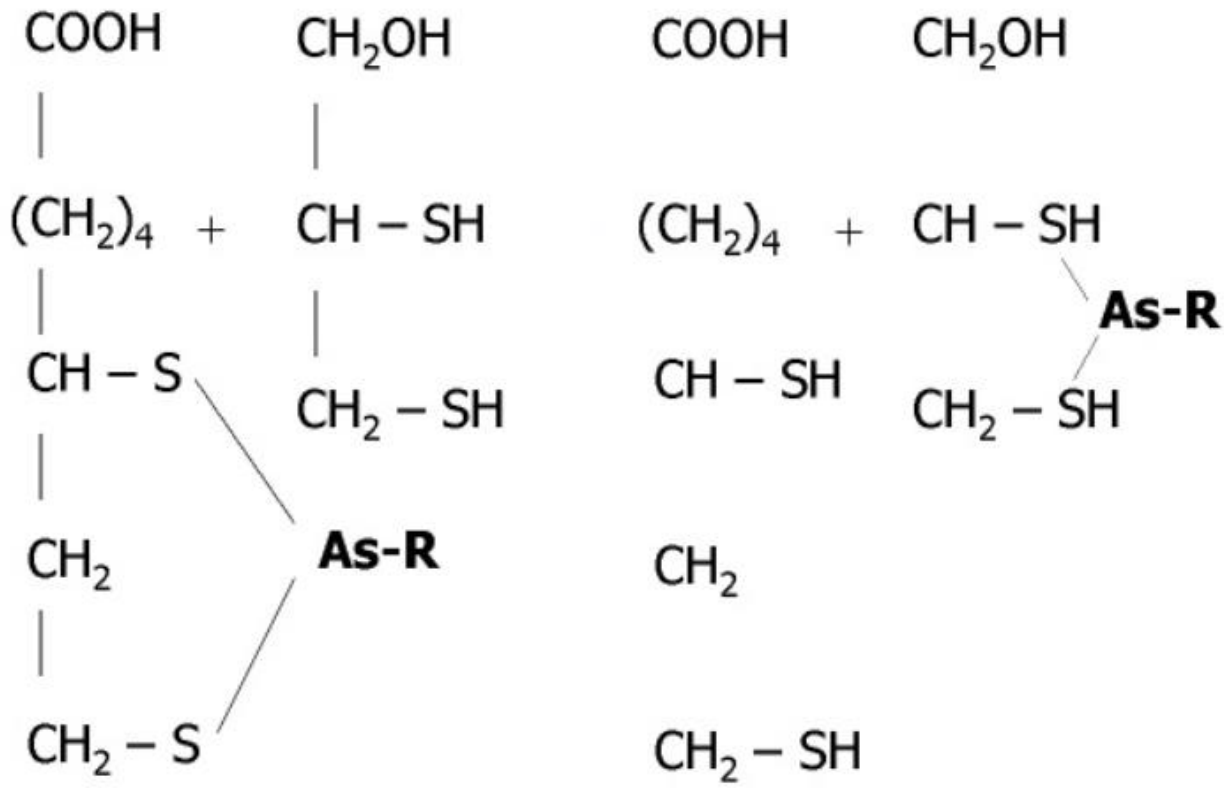
# Arsenic Uses, Part I

- Industrial processes
  - Semiconductors
  - Burning fossil fuels
  - Metallurgy
  - Glass clarification

# Arsenic Uses, Part II

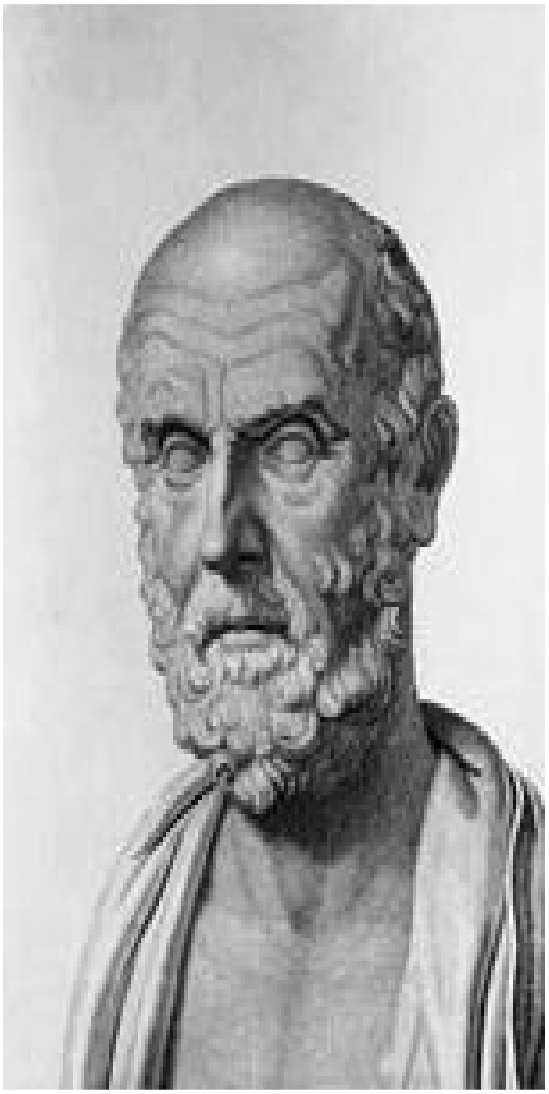
- Commercial products
  - Wood preservatives
  - Pesticides, herbicides, fungicides
- Lewisite (Chemical weapon)
  - British Anti Lewisite


COOH
(CH2)4
CH – SH
CH2
CH2 – SH
+ R-As=O
COOH
(CH2)4
CH – S
CH2
CH2 – S
As-R
+ H20


COOH
CH2OH
(CH2)4 +
CH – SH
CH – S
CH2 – SH
As-R
CH2
CH2 – S
COOH
CH2OH
(CH2)4 +
CH – SH
As-R
CH – SH
CH2 – SH
CH2
CH2 – SH

# Arsenic Uses, Part III

- Used as medicinal for 2500 years
  - Hippocrates
  - Paracelsus
  - Fowler
  - Ehrlich



# Famous Disasters

- 1900: English beer
- 1943: Scottish sausage
- 1955: Japan
  - Infant formula
- 1972: Minnesota, USA
  - (Not so) well water

# Routes of Exposure I

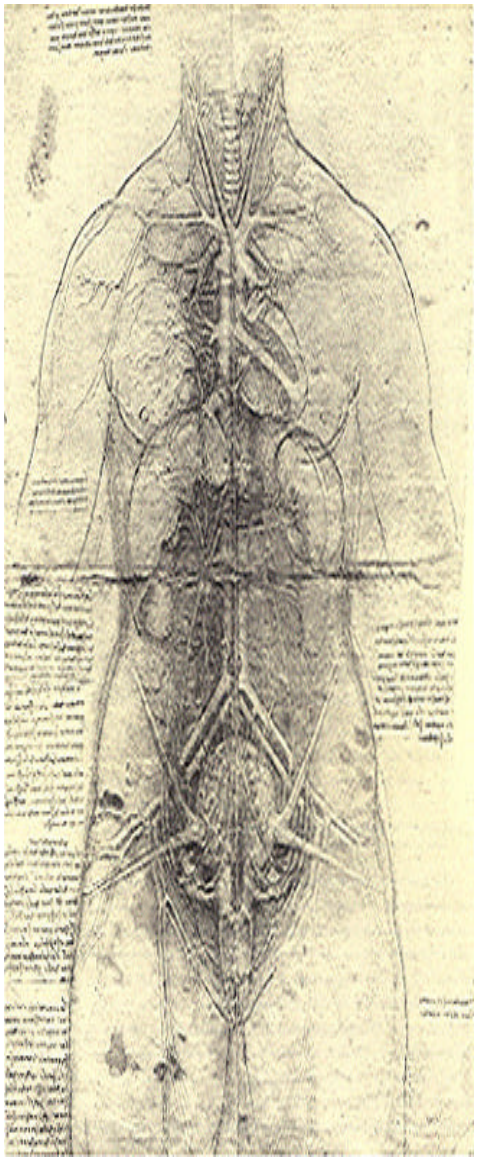
- Ingestion
  - 60-90% of ingested arsenic is absorbed
  - Primary cause of most reported cases of acute toxicity

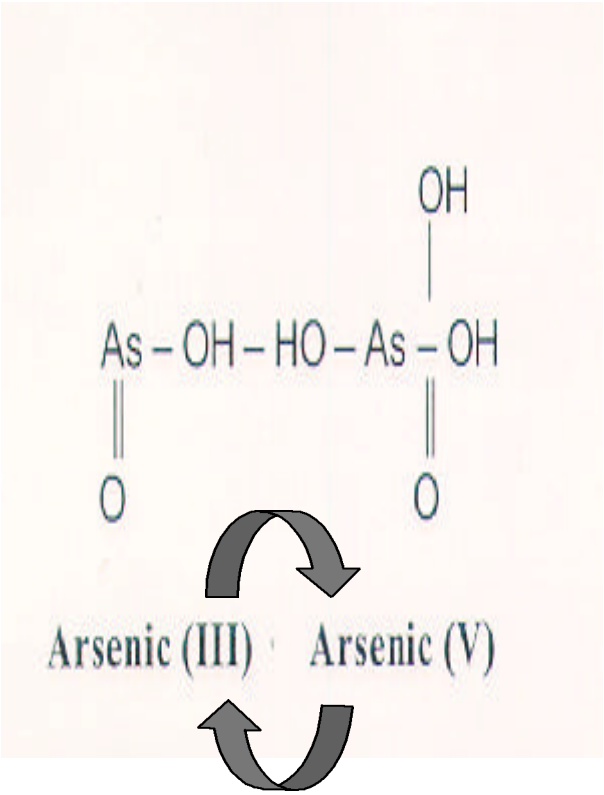
# Routes of Exposure II

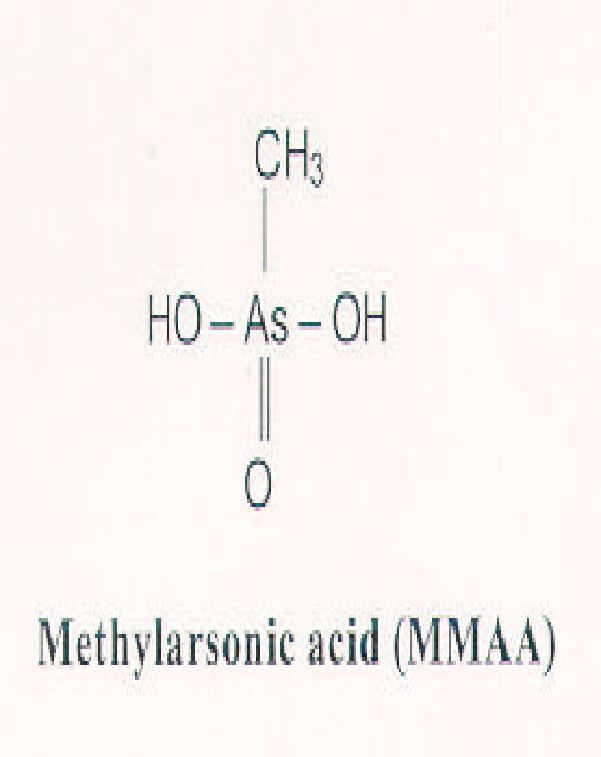
- Inhalation
  - 60-90% of inhaled dose is absorbed
  - May also be swallowed after clearance from upper airway
- Dermal

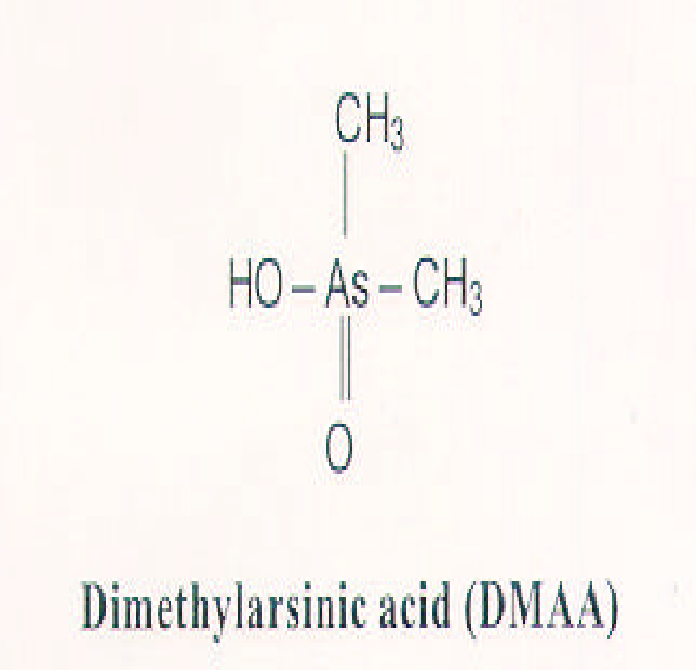
# Biological Fate

- Liver
- Kidneys
- Spleen
- Lungs
- GI tract
- Skin
- Hair
- Nails




OH
As – OH – HO – As – OH
O
O
Arsenic (III)
Arsenic (V)


CH3
HO – As – OH
O
Methylarsonic acid (MMAA)


CH3
HO – As – CH3
O
Dimethylarsinic acid (DMAA)

# Acute Exposure I

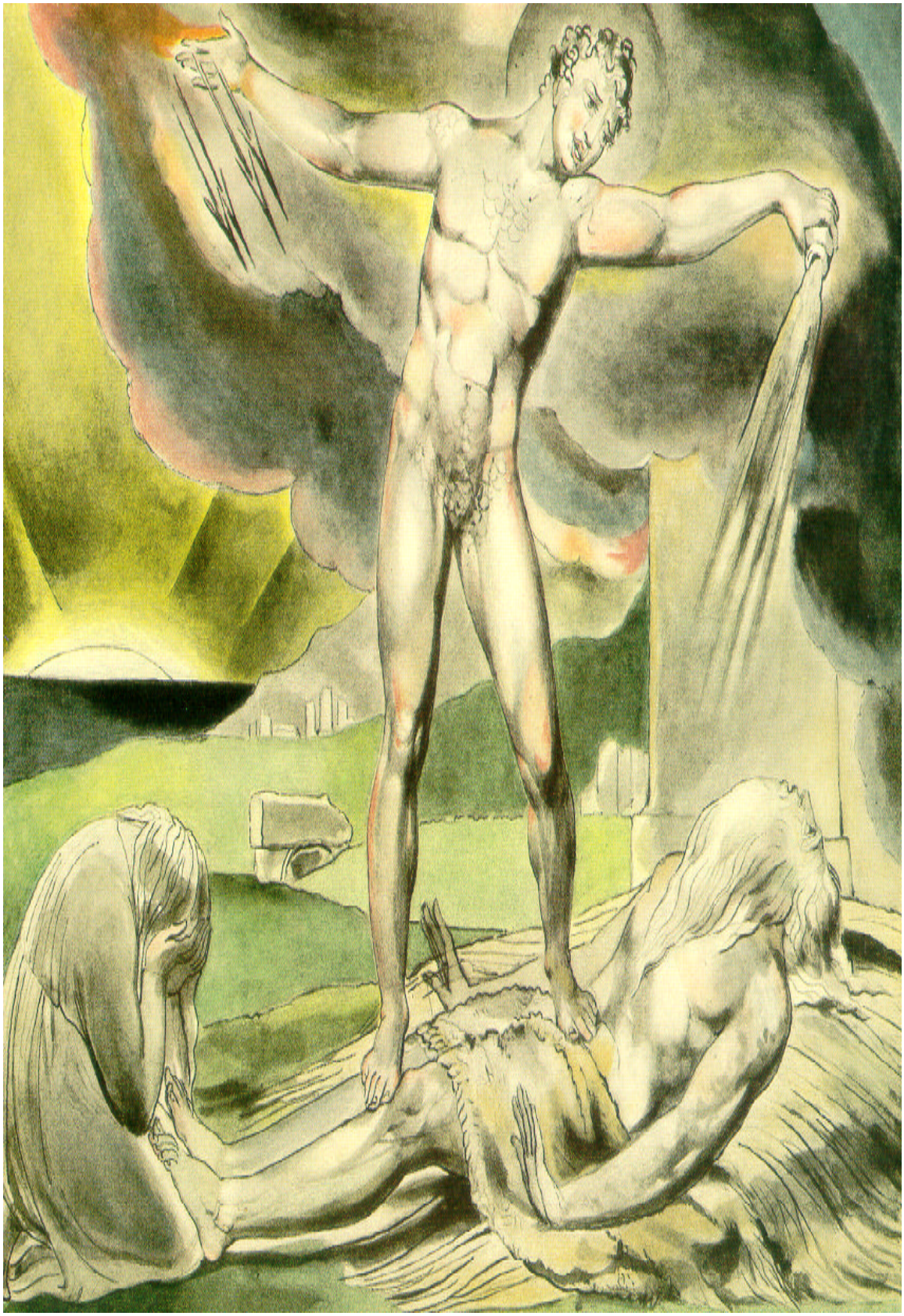
- **Gastrointestinal**
- **Neurological**
- **Cardiovascular (Heart)**
- **Respiratory (Lungs)**

# Acute Exposure II

- **Hepatic (Liver)**
- **Renal (Kidney)**
- **Hematological (Blood)**
- **Miscellaneous**

# Chronic Exposure

- Dermal (Skin)
- Neurological
- Hematological (Blood)
- Cancer
  - Lung
  - Skin



# CCA Poisonings

- Veterinary
- Suicides
- Inadvertent poisonings
- Occupational exposures

# Veterinary Poisoning

- Arsenic is a leading source of metal poisonings in domestic animals
- Cattle most commonly involved
  - Animals ingest burned CCA-treated lumber

# Suicide

- **Two known cases in the medical literature**
- **Case 1: victim died 36 hours after ingesting CCA**
  - **At autopsy: high levels of chromium and As**

Cross, et. al., Forensic Sci Int, 1979

# Suicide

- **Case 2: 33 y.o. man ingested CCA wood preservative 75 minutes before arrival in ED**
  - **Respiratory distress**
  - **Burns to mouth and upper airway**
  - **Died within two hours**

Hay, et. al., J Emerg Med, 2000

# Inadvertent Poisoning

- **Use of As treated lumber as a fuel source**
- **Case 1: 35 y.o. carpenter complained of “feeling cold”**
  - **Used timber remnants for cooking food**

Aitken, Papua New Guinea Med J, 1976

# Inadvertent Poisoning

- **Case 2: Three members of the same family and their dog**
  - **Ate steaks and vegetables cooked on open grill**
  - **Used timber off-cuts from nearby building site**

Geschke, et. al., Med J Australia, 1996

# Inadvertent Poisoning

- **Case 3: Family of eight in rural Wisconsin, USA**
  - **Heated their home during winter months with a small wood stove**
  - **Used “outdoor grade” wood and plywood**

Peters, et. al., NEJM, 1983; JAMA,1984

# Occupational Exposures

- Limited number of studies
- Few are well-designed
- NIOSH has conducted a few studies in the US

# Occupational Exposures

- **Report 1: Study looked at employees at 3 California wood processing plants**
- **Urinary As concentrations increased with exposure**
- **No significant differences in physical examinations**

Rosenberg, et. al., Am J Indust Med, 1980

# Occupational Exposures

- **Report 2: Case reports of 2 workers exposed to CCA-treated wood**
- **Forestry service workers building 30 picnic tables**
- **Poorly ventilated workspace**
- **Multiple health effects**

Peters, et. al., Acta Pharmacol Toxicol, 1986

# Occupational Exposures

- **Report 3: Occupational Exposure to Inorganic Arsenic in Wood Workers and Taxidermists**
- **Elevated As levels in urine of taxidermists and pylon workers (As +3) and in garden fence makers (As +5)**

Jensen & Olsen, J Environ Sci Health, 1995