Environmental Causes of Cancer

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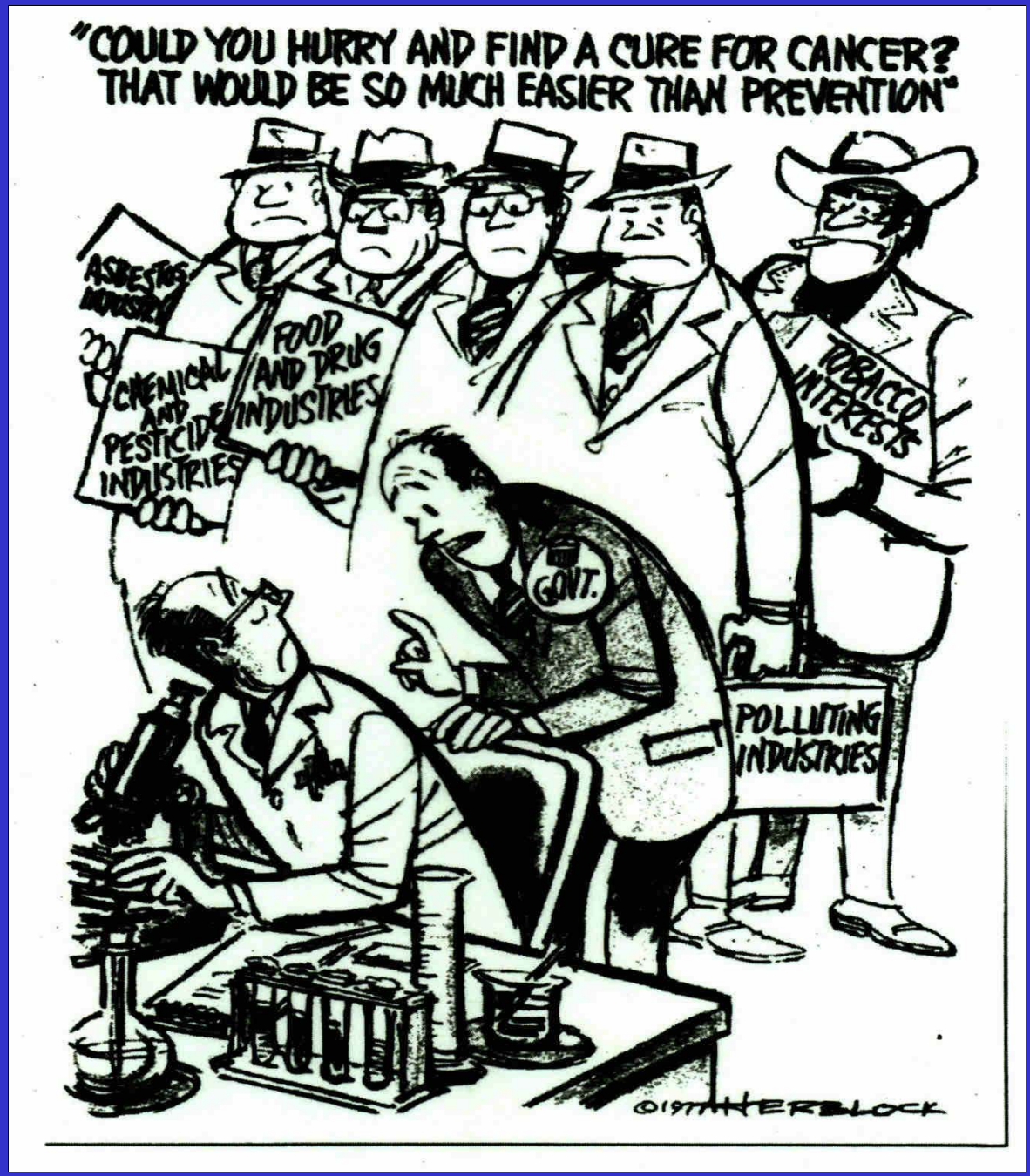
May 7, 2006

International Agency for Research on Cancer (IARC)

Evaluations of agents, mixtures, and exposures (as of July 2004)

Total agents evaluated	**900**
• Carcinogenic to humans	95
• Probably carcinogenic to humans	66
• Possibly carcinogenic to humans	241
• Not classifiable	497
• Probably not carcinogenic to humans	1

Source: International Agency for Research on Cancer. http://www-cie.iarc.fr/.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Substances and mixtures evaluated by IARC as definite human carcinogens and that are occupational exposures.

Substance or mixture	Occupation or industry in which the substance is found[a]	Site(s)
Physical agents		
Ionizing radiation and sources thereof, including, notably, X rays, γ rays, neutrons, and radon gas	Radiologists; technologists; nuclear workers; radium-dial painters; underground miners; plutonium workers; cleanup workers following nuclear accidents; aircraft crew	Bone[d] Leukemia[d] Lung[d] Liver[d] Thyroid[d] Others[d]
Solar radiation	Outdoor workers	Melanoma[d] Skin[d]
Respirable dusts and fibers		
Asbestos	Mining and milling; by-product manufacture; insulating; shipyard workers; sheet-metal workers; asbestos cement industry	Lung[d] Mesothelioma[d] Larynx[e] GI tract[e]
Erionite	Waste treatment; sewage; agricultural waste; air pollution control systems; cement aggregates; building materials	Mesothelioma[d]
Silica, crystalline	Granite and stone industries; ceramics, glass, and related industries; foundries and metallurgical industries; abrasives; construction; farming	Lung[d]
Talc containing asbestiform fibers	Manufacture of pottery, paper, paint, and cosmetics	Lung[d] Mesothelioma[d]
Wood dust	Logging and sawmill workers; pulp and paper and paperboard industry; woodworking trades (e.g., furniture industries, cabinetmaking, carpentry and construction); used as filler in plastic and linoleum production	Nasal cavities and paranasal sinuses[d]

Source: Siemiatycki et al. Listing occupational carcinogens. Table 3. *Environmental Health Perspectives*. 112(15):1447-57, Nov 2004. http://www.ehponline.org/.

Substances and mixtures evaluated by IARC as definite human carcinogens and that are occupational exposures, cont'd.

Metals and metal compounds		
Arsenic and arsenic compounds	Nonferrous metal smelting; production, packaging, and use of arsenic-containing pesticides; sheep dip manufacture; wool fiber production; mining of ores containing arsenic	Skin[d] Lung[d] Liver (angiosarcoma)[e]
Beryllium	Beryllium extraction and processing; aircraft and aerospace industries; electronics and nuclear industries; jewelers	Lung[d]
Cadmium and cadmium compounds	Cadmium-smelter workers; battery production workers; cadmium-copper alloy workers; dyes and pigments production; electroplating processes	Lung[d]
Chromium compounds, hexavalent	Chromate production plants; dyes and pigments; plating and engraving; chromium ferro-alloy production; stainless-steel welding; in wood preservatives; leather tanning; water treatment; inks; photography; lithography; drilling muds; synthetic perfumes; pyrotechnics; corrosion resistance	Lung[d] Nasal sinuses[e]
Selected nickel compounds, including combinations of nickel oxides and sulfides in the nickel refining industry	Nickel refining and smelting; welding	Lung[d] Nasal cavity and sinuses[d]
Wood and fossil fuels and their by-products		
Benzene	Production; solvents in the shoe production industry; chemical, pharmaceutical, and rubber industries; printing industry (rotogravure plants, bindery departments); gasoline additive	Leukemia[d]
Coal tars and pitches	Production of refined chemicals and coal tar products (patent-fuel); coke production; coal gasification; aluminum production; foundries; road paving and construction (roofers and slaters)	Skin[d] Lung[e] Bladder[e]

Source: Siemiatycki et al. Listing occupational carcinogens. Table 3. *Environmental Health Perspectives*. 112(15):1447-57, Nov 2004. http://www.ehponline.org/.

Childhood Brain Cancer: Documented Links

- Ionizing radiation [Strong]
- dichlorvos [Good]
- lindane [Good]
- Pesticides [Good]
- Second-hand smoke [Good]
- Solvents [Good]

Source: Solomon G, Schettler T, Janssen S. “CHE Toxicant and Disease Database.” Accessed 3-22-06: http://database.healthandenvironment.org/.

Melanoma: Documented Links

- UV radiation [Strong]

Thyroid Cancer: Documented Links

- Ionizing radiation [Strong]
- ethylene thiourea (ETU) [Good]

Source: Solomon G, Schettler T, Janssen S. “CHE Toxicant and Disease Database.” Accessed 3-22-06: http://database.healthandenvironment.org/.

Bone Cancer: Documented Links

- radium [Strong]
- Pesticides [Good]

Brain Cancer: Documented Links

- Ionizing radiation [Strong]
- Chromium [Good]
- methylene chloride [Good]

Source: Solomon G, Schettler T, Janssen S. “CHE Toxicant and Disease Database.” Accessed 3-22-06: http://database.healthandenvironment.org/.

Colo-rectal Cancer: Documented Links

- 1,1-dichloroethane [Good]
- alachlor [Good]
- Aromatic amines [Good]
- Chlorination by-products [Good]
- Ionizing radiation [Good]
- Solvents [Good]

Source: Solomon G, Schettler T, Janssen S. “CHE Toxicant and Disease Database.” Accessed 3-22-06: http://database.healthandenvironment.org/.

Prostate Cancer: Documented Links

- Agent Orange [Good]
- Aromatic amines [Good]
- methyl bromide [Good]
- Organochlorine pesticides [Good]
- PAHs [Good]
- Pesticides [Good]
- Solvents [Good]

Source: Solomon G, Schettler T, Janssen S. “CHE Toxicant and Disease Database.” Accessed 3-22-06: http://database.healthandenvironment.org/.

Childhood Leukemias: Documented Links

- benzene [Strong]
- Ionizing radiation [Strong]
- Agent Orange [Good]
- carbon tetrachloride [Good]
- Chlorinated solvents [Good]
- Metal dusts [Good]
- Pesticides [Good]
- Secondhand smoke [Good]
- trichloroethylene (TCE) [Good]

Source: Solomon G, Schettler T, Janssen S. “CHE Toxicant and Disease Database.” Accessed 3-22-06: http://database.healthandenvironment.org/.

Liver Cancer: Documented Links

- aflatoxin B1 (Aflatoxins) [Strong]
- Androgens [Strong]
- ethyl alcohol (ethanol) [Strong]
- Hydrocarbons [Strong]
- N-nitrosodimethylamine [Strong]
- arsenic [Good]
- captafol [Good]
- PCBs [Good]
- thorium dioxide (Thorostat) [Good]
- trichloroethylene (TCE) [Good]
- vinyl chloride [Good]

Source: Solomon G, Schettler T, Janssen S. “CHE Toxicant and Disease Database.” Accessed 3-22-06: http://database.healthandenvironment.org/.

IARC: Examples of agents classified as human carcinogens (not necessarily found in occupational settings)

- Alcohol - in alcoholic drinks
- Arsenic - in drinking water, wood preservatives, pesticides
- Benzene - in vehicle exhaust, cigarette smoke, and some detergents, drugs, dyes, pesticides, plastics, etc.
- Cadmium - as a stabilizer in PVC products, in re-chargeable batteries & phosphate fertilizers
- Dioxin - production or combustion of chlorinated dyes, herbicides, some drugs & wood preservatives
- Formaldehyde - in resins in common household materials and products
- Oestrogen therapy - hormone replacement therapy
- Oral contraceptives - birth control pills
- Radiation - (ionizing) in radioactive material, high-voltage equipment, nuclear reactions, stars
- Tamoxifen - breast cancer treatment
- Vinyl chloride - in polyvinyl resins

Breast Cancer: Documented Links

- Active smoking [Strong]
- Estrogens/DES [Strong]
- ethyl alcohol (ethanol) [Strong]
- Ionizing radiation [Strong]
- Secondhand smoke [Strong]
- Aromatic amines [Good]
- B-naphthylamine [Good]
- benzidine [Good]
- ethylene oxide [Good]
- PAHs [Good]
- PCBs [Good]
- Progestins [Good]
- Solvents [Good]
- tetrachloroethylene (PCE) [Good]

Source: Solomon G, Schettler T, Janssen S. “CHE Toxicant and Disease Database.” Accessed 3-22-06: http://database.healthandenvironment.org/.

Non-Hodgkin's Lymphoma: Documented Links

- 1,3-butadiene [Strong]
- benzene [Strong]
- Dioxins/TCDD [Strong]
- 2,4-D [Good]
- Agent Orange [Good]
- aldrin [Good]
- Aromatic amines [Good]
- captan [Good]
- Carbamates [Good]
- carbaryl [Good]
- carbon disulfide [Good]
- carbon tetrachloride [Good]
- Chlorophenols [Good]
- Chlorophenols [Good]
- Creosotes [Good]
- DDT/DDE [Good]
- dicamba [Good]
- dichlorvos [Good]
- Fungicides [Good]
- Insecticides [Good]
- Ionizing radiation [Good]
- lindane [Good]
- malathion [Good]
- MCPA [Good]
- mecoprop [Good]
- Organochlorine pesticides [Good]
- Organophosphates [Good]
- PCBs [Good]
- Pesticides [Good]
- Phenoxyacetic herbicides [Good]
- Secondhand smoke [Good]
- Solvents [Good]
- tetrachloroethylene (PCE) [Good]
- trichloroethylene (TCE) [Good]

Source: Solomon G, Schettler T, Janssen S. "CHE Toxicant and Disease Database." Accessed 3-22-06: http://database.healthandenvironment.org/.

Doll & Peto, 1981

TABLE 20.—*Proportions of cancer deaths attributed to various different factors*

Text section No.	Factor or class of factors	Percent of all cancer deaths	
		Best estimate	Range of acceptable estimates
5.1	Tobacco	30	25–40
5.2	Alcohol	3	2–4
5.3	Diet	35	10–70
5.4	Food additives	<1	−5[a]–2
5.5	Reproductive[b] and sexual behaviour	7	1–13
5.6	Occupation	4	2–8
5.7	Pollution	2	<1–5
5.8	Industrial products	<1	<1–2
5.9	Medicines and medical procedures	1	0.5–3
5.10	Geophysical factors[c]	3	2–4
5.11	Infection	10 ?	1–?
5.12	Unknown	?	?

Source: Doll R, Peto R. The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today. *Journal of the National Cancer Institute*. 1981. 66(6):1191-1308.

Doll & Peto, 1981

Notable Limitations:

- Relied on epi studies of workers in large industries.
- Did not consider exposures in smaller work places.
- Did not consider exposures from indirect contact with carcinogens.
- Excluded deaths of people 65 and over!

Source: Clapp R, Howe G, Jacobs M. “Environmental and Occupational Causes of Cancer,” 2005.

Doll & Peto, 1981 and 1998

Acknowledged:

- Some exposures interact with each other.
- Sum of causes could only be more than 100%.
- Proportions are impossible to estimate because all avoidable causes are unknown.

Sources: 1) Doll R, Peto R. The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today. *Journal of the National Cancer Institute*. 1981. 66(6):1191-1308. 2) Doll R. Epidemiological evidence of the effects of behaviour and the environment on the risk of cancer. *Recent Results in Cancer Research*. 1998. 154:3-21.

Harvard Center for Cancer Prevention, *Human Causes of Cancer*, 1996

Stated purpose:

- To make sense of "public confusion about cancer prevention…"

  "…the public can become overly concerned about minimal risks while losing sight of major cancer risk factors that can be controlled or modified, in particular, tobacco use, diet, exercise, and sun exposure."

Sources: 1) Harvard Center for Cancer Prevention, *Volume I: Human Causes of Cancer*, 1996. http://www.hsph.harvard.edu/cancer/resources_materials/reports/HCCPreport_1intro.htm.

Harvard Center for Cancer Prevention, *Human Causes of Cancer*, 1996

- "…supported by the generous contributions of Margorie G. and Vincent L. Gregory Jr."

  When CEO of Rohm & Haas, Gregory described additional worker fatalities due to respiratory cancer from BCME exposure at a Pennsylvania plant as "inevitable."

Sources: 1) Harvard Center for Cancer Prevention, *Volume I: Human Causes of Cancer*, 1996. http://www.hsph.harvard.edu/cancer/resources_materials/reports/HCCPreport_1intro.htm. 2) Randall WS and Solomon SD. *Building 6 – The Tragedy at Bridesburg*. Little, Brown & Co., Boston, 1979, p. 66.

A Few Lessons from History

1775	Scrotal cancer in small boys linked to their work assisting chimney sweeps. (PAHs)
1800's	Pipe smoking recognized as a cause of cancer of the lip.
1903-06	First reports of cancers caused by X-ray exposure.
1915	Smoking linked to cancer of the mouth.
1920's	Smoking linked to lung cancer.

Sources: 1) Clapp R, Howe G, Jacobs M. "Environmental and Occupational Causes of Cancer," 2005. 2) Proctor, RN. *Cancer Wars*. New York: Basic Books, 1995.

A Few Lessons from History

Early 1900's	Bone, nasal, & stomach cancers linked to women and girls who were radium dial painters. (Radiation)
1936, 1938	First documentations of asbestos and lung cancer link.
1946	Radiologists found 8x more likely to die of leukemia than other doctors.

Sources: 1) Clapp R, Howe G, Jacobs M. "Environmental and Occupational Causes of Cancer," 2005. 2) Proctor, RN. *Cancer Wars*. New York: Basic Books, 1995.

A Few Lessons from History

1950s	Scrotal cancer in men linked to work with cutting oils.
1950s	Lung cancer in excess among uranium ore miners of the Colorado Plateau.
1970's	20,000 children irradiated for ringworm treatment had 6x the risk of developing cancers (higher for brain & leukemia).
1976	Dioxin spilled in Seveso, Italy industrial accident led to elevated leukemia, multiple myeloma, Hodgkin's disease, stomach, rectal, liver, soft tissue sarcomas, non-Hodgkin's lymphoma, and hematologic neoplasms.

Sources: 1) Clapp R, Howe G, Jacobs M. "Environmental and Occupational Causes of Cancer," 2005. 2) Proctor, RN. *Cancer Wars*. New York: Basic Books, 1995.

A Few Lessons from History

Tom's River, NJ

Trichloroethylene Radium

In drinking water from early 1980s to 1990s; parents noticed increased childhood cancer in support group called "Ocean of Love." Dumping of chemicals in landfill suspected.

→ Studies found statistical link between exposure (especially prenatal exposure) to contaminated drinking water and risk of leukemia

Source: New Jersey Dept. of Health and Senior Services, Environmental Epidemiology Division, 2003.

A Few Lessons from History

Recent studies:

- Ionizing radiation linked to cancers of the bladder, bone, brain, breast, colon, liver, lung, ovary, rectum, salivary gland, skin, stomach, and thyroid, as well as leukemia, mesothelioma, multiple myeloma, non-Hodgkin's lymphoma, and sarcomas.
- Smoking has been linked to cancers of the bladder, breast, cervix, kidney, larynx, lung, mouth, nasopharynx, oesophagus, pancreas, and adult on-set leukemia.
- Asbestos exposure linked to cancers of the kidney, larynx, lung, and stomach and to mesothelioma.

Sources: 1) Clapp R, Howe G, Jacobs M. "Environmental and Occupational Causes of Cancer," 2005. 2) Solomon, Schettler, Janssen. "CHE Toxicant and Disease Database" http://database.healthandenvironment.org/

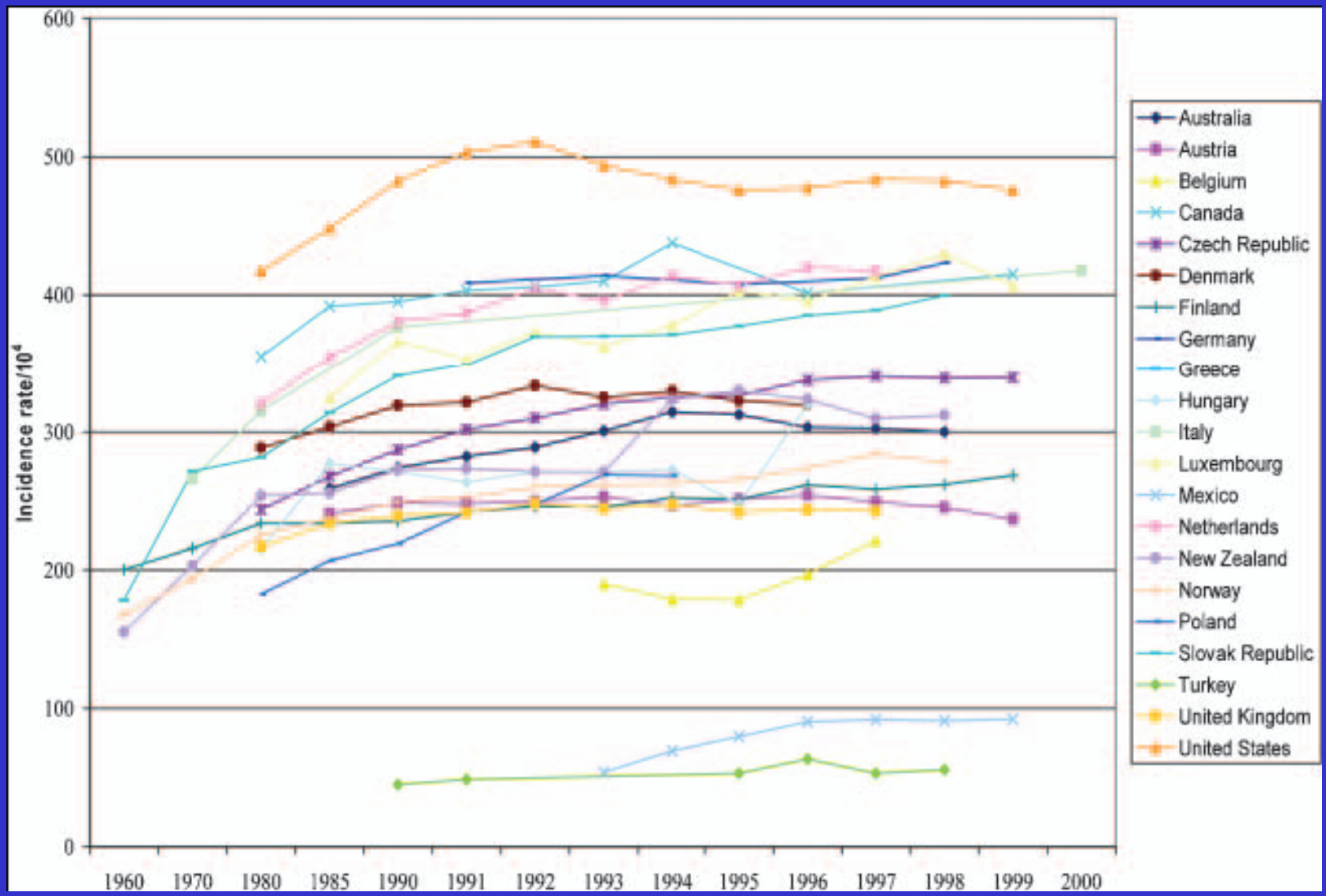
A Few Lessons from History

Elevated cancer rates are found:

- In farming states
- In areas of pesticide use
- Near hazardous waste sites and incinerators
- Downwind of certain industrial activities
- Near certain drinking-water wells
- In cities
- Among workers exposed to toxins
- Among children whose parents work with toxins.
- Associated with other sources of pollution.

Source: Clapp R, Howe G, Jacobs M. Environmental and Occupational Causes of Cancer. 2005. www.healthandenvironment.org.

Trends in cancer incidence rates in “developed” countries.



Source: Newby JA, Howard V. Environmental influences in cancer aetiology. Journal of Nutritional & Environmental Medicine. Review. 2006, 1-59.

A Few Lessons from History

- Immigrants acquire the cancer rates of their new country within 1-2 generations.
- Among twins, environmental exposures unique to those with breast cancer made the most significant contribution to the development of the disease.

Sources: 1) Clapp R, Howe G, Jacobs M. Environmental and Occupational Causes of Cancer. 2005, www.healthandenvironment.org. 2) State of the Evidence: What is the Connection Between the Environment and Breast Cancer? 2006, www.breastcancerfund.org and www.bcaction.org.

A Few Lessons from History

Good news!

- A ban on 2 pesticides linked to NHL led to a subsequent reduction in NHL rates in Sweden and other countries.
- Decreased air pollution leads to fewer deaths from lung cancer and other diseases.
- Australia's successful "Slip, Slop, Slap" campaign against skin cancer.

  → The sun has no stockholders!

Sources: 1) Howe GK and Clapp RW. Are We Winning or Losing the War on Cancer? Deciphering the propaganda of NCI's 33-year war. *New Solutions: A Journal of Environmental and Occupational Health Policy*, Vol. 14, No. 2, 2004. 2) Bakalar N. Cleaner Air Brings Drop in Death Rate. The New York Times, March 21, 2006. 3) Proctor R. Cancer Wars, 1998.

A Few Lessons from History

Sid the Seagull

Slip, Slop, Slap!
It sounds like a breeze when you say it like that
Slip, Slop, Slap!
In the sun we always say "Slip Slop Slap!"
Slip, Slop, Slap!
Slip on a shirt, slop on sunscreen and slap on a hat,
Slip, Slop, Slap!
You can stop skin cancer - say: "Slip, Slop, Slap!"

Source: The Cancer Council Australia, Sunsmart. http://www.cancer.org.au/.

A Few Lessons from History

"Environmental carcinogenesis is the newest and one of the most ominous of the endproducts of our industrial environment. Though its full scope and extent are still unknown..., enough is known to make it obvious that extrinsic carcinogens present a very immediate and pressing problem in public and individual health."

-- Wilhelm Hueper, senior scientist
U.S. National Cancer Institute
Environmental Cancer, 1948

A Few Lessons from History

"Future historians may well be amazed by our distorted sense of proportion. How could intelligent beings seek to control a few unwanted species by a method that contaminated the entire environment and brought the threat of disease and death even to their own kind? Yet this is precisely what we have done."

-- Rachel Carson, *Silent Spring*, 1962

The Precautionary Principle

- Indication of harm, not proof of harm, is a call to act.
- The proponent of an activity, rather than the public, should bear the burden of proof.
- Decision-making must be open, informed and democratic and must include potentially affected parties.
- Decision-making must also involve an examination of the full range of alternatives, including no action.

-- from the Wingspread Statement, 1998

The Precautionary Principle

"If the lessons from the tobacco control experience are applied in other areas, even greater gains can be made in cancer prevention."

-- Canadian Cancer Statistics 2005

The Need to Act on What We Know

"It is time to start pursuing alternative paths. From the right to know and the duty to inquire flows the obligation to act."

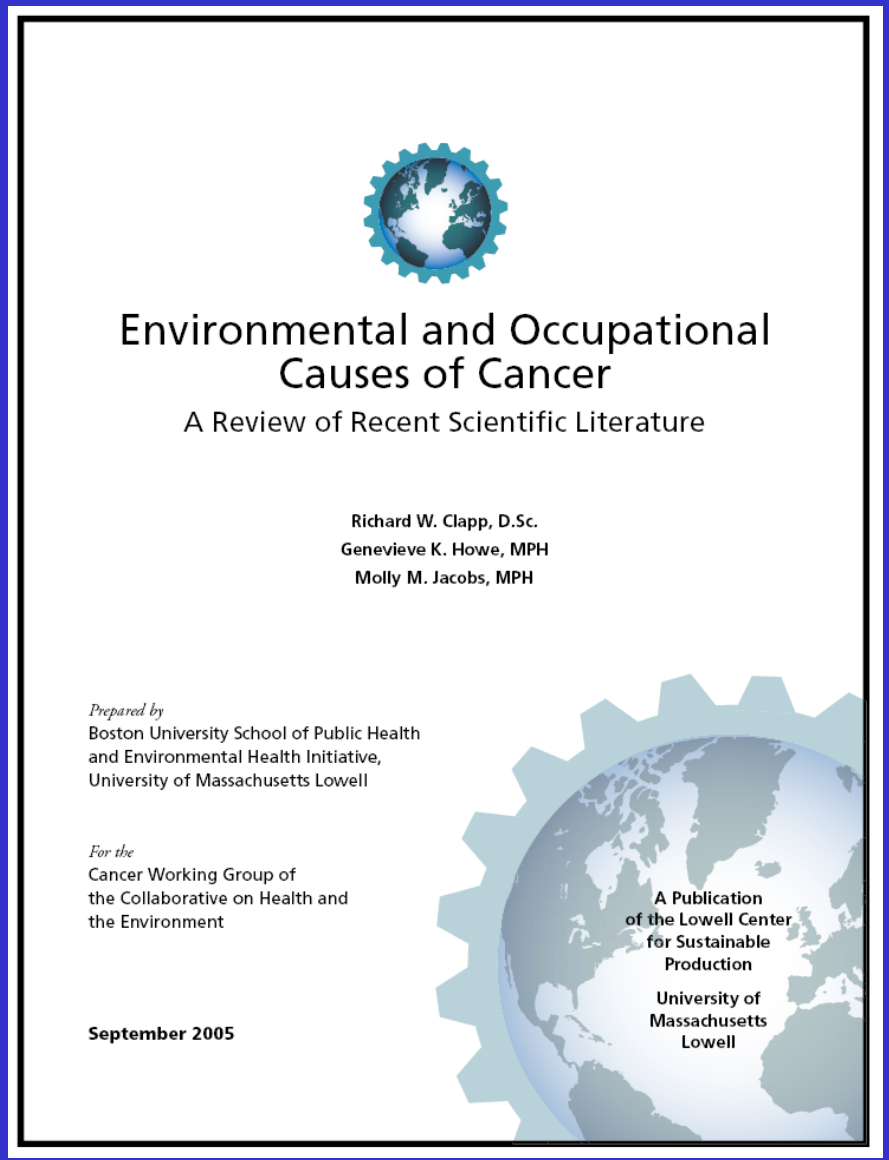
-- Sandra Steingraber
Living Downstream, 1997

The Need for Social and Political Changes

There is no
scientific solution
to a social problem.

-- Judith Brady, Cancer activist
San Francisco, 2006

Resources



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September 2005

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