Institute of Biomedical Science

Occupational Diseases: Working with Dangerous Chemicals

Radium dial painters at work in the USA in the 1920s.

In 1775, Percival Pott associated scrotal cancer in chimney sweeps with soot.

Historically, the weighing out and manipulation of dangerous chemicals frequently occurred without adequate protection from inhalation or accidental ingestion. The use of gloves, eye protection using goggles, masks or visors was scant.

Dangerous chemicals

Examples of common dangerous chemicals in the laboratory include the following:

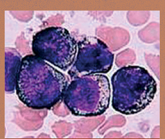
Benzidine	Used to detect blood. Bladder carcinogen
Saponin	Non-ionic surfactant Irritant/haemolytic agent
Sudan black	Fat stain. Irritant and damaging when ingested
Glutaraldehyde/formaldehyde	Tissue fixatives Irritants and possible carcinogens
Alpha-naphthol	Carbohydrate detection Possible bladder carcinogen

Working with carcinogens

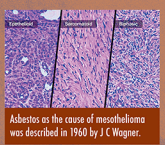
- Carcinogenic agents are chemicals with the potential to cause cancer by inducing genetic mutations and thus promote the formation of tumours.
- Over 900 chemicals have been assessed over a period of 30 years and around 100 have been confirmed as causing cancer in humans.
- It is estimated that around five percent of cancer-related deaths are attributable to occupational exposure to carcinogens.

Evidence of carcinogenicity

Evidence of carcinogenicity has been determined in the past by animal studies and, more recently, by cell culture studies. Those chemicals giving rise to cancer in animals also give rise to cancer in humans, although differences in dosages were often apparent.



Sudan black staining, a ubiquitous method across various pathology disciplines, including in leukaemia diagnosis.



Asbestos as the cause of mesothelioma was described in 1960 by J C Wagner.

Ames method

- Bruce Ames, the American biochemist, developed a bacterial procedure using cultures of *Salmonella typhimurium* in the early 1970s to identify carcinogens (McCann *et al.* 1975).
- The organisms used had a mutation so that cultures required histidine to grow.
- The addition of rat liver homogenate and a possible carcinogen could induce a mutation thus increasing the number of colonies.
- Ames' early studies of almost 200 suspect chemicals gave a 90% positive result rate.

Use of epidemiological studies

- Controlled studies of comparative frequency of cancer in the workplace using a candidate carcinogen is compared to the frequency in the general population.
- This, however, may be limited by non-workplace exposures and the need for long-term studies as long periods of time may occur between exposure and the development of cancer (e.g. bladder cancer).

Percival Pott

Carcinogens in the workplace

A number of identified carcinogens have been identified in industrial processes and other occupations. The table below lists those positively identified and their sources.

Carcinogenic agent	Occupation/process	Cancer type
Asbestos	Construction electricians, shipyards, old floor tiles	Lung, stomach
Benzene	Oils and solvents	Leukaemia
Benzo(a)pyrene	Foundry work	Lung
Coal tar/pitch	Road maintenance, construction	Skin, bladder
Formaldehyde	Laboratories, textile and wood industries	Nasopharynx
Ionising radiation	Radiology, nuclear industry	Bone, breast, liver
Mineral oils	Metal working	Bladder, skin
Radon (naturally occurring)	Quarries, mines	Lung
Certain pesticides	Farming industry	Skin, lymphatics
Silica dust	Construction, mining	Lung
Tetrachlorethylene	Painters	Non-Hodgkin's lymphoma, cervix
Vinyl chloride	Refrigerants, adhesives	Angiosarcoma
Wood dusts	Construction, wood mills	Nasopharynx

Working with poisonous heavy metals

A number of identified carcinogens have been identified in industrial processes and other occupations. The table below lists those positively identified and their sources.

Heavy metal	Industrial use/development	Hazard
Cadmium	Cement production, iron and steel industry, fossil fuel industry and waste industry, PVC manufacture and electroplating	Ingestion, inhalation of fumes
Mercury	Measuring device production, lamp manufacture, battery production, dental amalgam, gold mining and paper industry	Inhalation of vapour, skin absorption and ingestion
Lead	Metal plating, battery waste production, ore smelting, plumbing, and fertiliser and pesticide production	Inhalation of fumes and dust, skin absorption
Chromium	Tanning, electroplating, petroleum industry and oil drilling	Skin absorption, ingestion and inhalation of vapours
Arsenic	Mining, processing of metal ores and smelting industry	Ingestion and skin absorption

Prevention of disease caused by heavy metals

Monitoring exposure

- Materials analysis: delineating the metal content of raw materials.
- Air monitoring: using the measurement of the concentration in the workplace air.
- Biological monitoring: the most recent measurements used, involving the assessment of blood levels in industrial workers.

Development of the fume cupboard/hood

- In 1900 Thomas Edison became the first scientist to be concerned about laboratory ventilation.
- Edison used the fireplace chimney in his laboratory to exhaust "noxious fumes and odours" from his experiments.
- The first recognisable fume hood put to use at the University of Leeds in 1923.
- Labconco (USA) developed the first commercially available fume hood in 1936.
- 1943: John Webster working at Ames develops constant face velocity using a dedicated exhaust fan.
- 1950: John Turner of The Oak Ridge National Laboratory improves the design.
- Various further design improvements occur between the 1960s and the 1990s.
- 2005: The Adiprol fume hood developed which had high chemical resistance and was totally fireproof.
- 2009: Ductless fume hoods with phase filtration, filtration monitoring, airflow control and a universal filtration system for organic acids, alcohols, hydrocarbons, esters, aldehydes, halogens and inorganic acids becomes available.

Developments in carcinogen history

The 1700s

- Diseases of Workers (published in 1760 by Ramizzini in Italy) was the first comprehensive work on the occupational diseases outlining the health hazards of irritating chemicals, dust, metals and other agents encountered by workers in 52 different occupations.
- Snuff (a product of tobacco) was shown by John Hill to be a possible cause of nasal cancer in 1771.
- Percival Pott, in 1775, associated scrotal cancer in chimney sweeps with soot, leading to the Chimney Sweep Act of 1788.

The 1800s

- Benzene, a known carcinogen, was isolated from coal tar in 1845.
- Bladder cancer was described in dye industry workers by Ludwig Reyn in 1895.

The 1900s

- In 1902 the somatic mutation theory was published by Theodor Boveri.
- Official compensation was approved in 1907 for skin cancer sufferers handling tar or pitch.
- Painted coal tar associated with cancer in 1915 and the occupational development of cancer becomes a notifiable condition in 1920.
- Luminous paint containing radium, dibenzene anthracene, benzo(a)pyrene and benzene all linked to cancer causation between 1922 and 1995.
- Asbestos as the cause of mesothelioma described in 1960 by J C Wagner.
- Carcinogenic Substances Regulations published in 1967.
- Hepatitis B virus was identified as a trigger for hepatocellular carcinoma by Palmer Beaseley in 1981.
- Hepatitis C identified as a cause of liver cancer (Alberti, 1999).
- Smoking as a cause of lung cancer delineated in 1995.

Occupational Health: Work and Play Can Make You Sick
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