

A SHORT HISTORY OF OCCUPATIONAL DISEASE: 2. ASBESTOS, CHEMICALS, RADIUM AND BEYOND

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ABSTRACT

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. From Canary Girls and chimney sweeps to miners, stone cutters and silo fillers, these are classic exemplars of the subtle (and in some cases not so subtle) effects that substances, environments and practices can have on individual health.

INTRODUCTION

It has been known for many centuries that certain diseases were associated with particular occupations (i.e. wool-sorters disease in the textile industry, cowpox in milk maids and respiratory problems in miners and stone workers). It is only in relatively recent history that the cause of many of these conditions was understood, as this paper illustrates.

DANGEROUS CHEMICALS

All chemicals used in work practices or elsewhere pose specific hazards, some of which may result, with sufficient exposure, in a range of occupational diseases. Most chemicals are irritant to the skin or mucous membranes, while others are toxic, allergenic, carcinogenic, mutagenic or teratogenic via skin contact and absorption, inhalation or accidental ingestion.¹

In 1700 an Italian physician, Bernardino Ramazzini, published the results of his comprehensive studies in *De Morbis Artificum Diatriba* (Diseases of Workers) which described an association between irritating chemicals, dust, metals and other abrasive agents covering 54 different occupations.² Ramazzini also noted asthma-like symptoms and dust-like particles in the lungs of bakers and millers.³ Legislation and compensation systems were slow to develop during the 19th century but were an attempt to respond to an increasing use of chemicals and their resultant hazards to health.

Historically, in the medical laboratory substances such as benzene, benzidine, formaldehyde, 2 naphthylamine, nitroso compounds, a wide range of metal salts and certain organic solvents were widely used, often without adequate protection, and the use of gloves, eye protection, masks and visors was scant. These substances are now classified as Group 1 human carcinogens.⁴ Occupational dermatitis and occupational asthma by chemical contact and inhalation, respectively, have become more recent significant health problems.⁵

OCCUPATIONAL CANCER

Towards the end of the 18th century, a possible causal link between chemicals and cancer was reported by two London surgeons. In 1761, John Hill reported an association between snuff, a tobacco product, and nasopharyngeal cancer, and, in 1775, Percival Pott described a high incidence of scrotal cancer in chimney sweeps. Pott, a surgeon at St Bartholomew's Hospital in London, published his findings,⁶ which he attributed to contamination with soot. This excellent epidemiological study is considered to be the first report of a potential carcinogen. Pott's work led to the foundation of occupational medicine and to the Chimney Sweep Act of 1788. In 1895, Ludwig Reyn reported that aromatic amines used in certain dye industries in Germany were linked to bladder cancer. In 1907, compensation was awarded to workers with skin cancer as a result of handling tar or pitch, and occupational cancer became a notifiable disease in 1920.

In 1902 the somatic mutation theory was published by Theodor Boveri⁷ as an attempt to explain cancer development. It is now known that carcinogens include chemicals, ionising radiation and certain viruses that have the potential to cause cancer by inducing genetic mutations that may promote conditions for the development of tumours. This effect depends on the carcinogen, mode and period of exposure, a person's lifestyle and their genetic susceptibility. It is estimated that there are around 120 Group 1 human carcinogens identified and that historically it has been estimated that around 5% of cancer-related deaths are attributable to occupational exposure to carcinogens.^{8,9} Between 1922 and 1995, luminous paint containing radium, the chemicals dibenzene, anthracene, dibenzo(a)pyrene, asbestos and hepatitis B virus, hepatitis C virus and smoking were all identified as causes of cancer

Bruce Ames, an American biochemist, developed a bacterial culture procedure using cultures of *Salmonella typhimurium* in the early 1970s.¹⁰ The organisms he used had a mutation so that cultures required histidine to grow. The addition of a rat liver homogenate and a possible carcinogen could induce a mutation, thus increasing the number of colonies on the culture. Ames' early studies of almost 200 suspect chemicals gave a 90% positive result rate. Animal studies and, more

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recently, cell culture has revealed that chemicals giving rise to cancer in animals also give rise to cancer in humans, although differences in dosages were often apparent.

Controlled studies of comparative frequency of cancer in the workplace using a candidate carcinogen was compared to the frequency in the general population but was 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 (eg bladder cancer).

WAS LEWIS CARROLL'S 'HATTER' MAD OR POISONED?

In the 19th century mercuric nitrate was used to remove hair from the skin of animals such as rabbits. The hair was shaped into felt cones, then shrunk in boiling water. Treated felts thus released volatile mercury, which had a toxic effect on hatters and milliners, resulting in erethism. Symptoms of erethism include delirium, hallucinations, irritability and excitability.

OTHER OCCUPATIONAL DISEASES

From 'Canary Girls' and chimney sweeps to miners, stone cutters and silo workers, these are classic exemplars of the subtle, and not so subtle, effects that substances, environments and practices had on individual health. Reid (1957)¹¹ also researched the incidence of tuberculosis in non-laboratory health workers and reported high levels among chest physicians and surgeons (4.0/1000), and Gehanno (2016),¹² working in France, reported an incidence of 0.075/1000 in nursing staff.

Many podiatrists have been found to be hypersensitive to dust from nails, resulting from the use of grinding burrs, and have suffered from asthma, allergic rhinitis and conjunctivitis. High levels of serum precipitating antibodies to *Trichophyton rubrum*, the common cause of nail dystrophy, have been recorded in this group of workers.

Radium was discovered by Marie and Pierre Curie in 1898 and was purified as a metal in 1911. In 1917, the US Radium Company produced a radium-infused paint which was used to paint numbers on clock and watch dials that glowed in the dark. Women undertaking this work would lick their brushes to produce a fine point and some developed jaw abnormalities, severe anaemia, leukaemia and sarcomas. Seriously affected women (called 'Radium Girls') were awarded \$10,000 compensation together with \$600 a year for ongoing medical and living expenses.

During the First World War a shortage of munitions led to the so-called 'shell crisis', and so the Munitions of War Act, passed in 1915, brought all private armament companies under Government control. Over one million women were employed in the munitions industry and their conditions of work, wages and hours were brought under strict control. Three hundred deaths occurred due to explosions (silk clothing being banned to prevent the occurrence of static electricity). The manufacture of tri-nitro toluene (TNT) involved the use of nitric and sulphuric acids, the fumes

from which turned both skin and hair yellow (hence 'Canary Girls'). Toxic jaundice was reported in 400 women with 100 deaths occurring. Pregnancy in these women gave rise to yellow 'Canary Babies'.

The nature of the environment in which sewer workers are occupied presents particular risks. Although gastroenteritis is likely to be a common risk, the most serious problem is Weil's disease (the most serious form of leptospirosis). Hepatitis A and allergic alveolitis may also occur.

Asbestos exposure in electricians and in the construction industry was very common in the past. Mereweather and Price¹³ found that the greater the exposure to asbestos fibres the greater the risk of developing mesothelioma. By 2015 a total of 157,000 persons were recorded as having asbestosis, with 3600 deaths.

Miners and stonecutters have suffered from pneumoconiosis and silicosis throughout history. Respiratory disease from breathing dust dates back to ancient Greece. Agricola in 1556 CE¹⁴ reported lung problems from dust inhalation in miners, and have been known in history as miner's phthisis, grinders asthma and potter's rot. The pneumatic hammer drill (1897) and sandblasting (1904) led to an increase in silicosis, and by 1990 the number deaths in miners due to pneumoconiosis in the UK reached 29,000. Moreover, pneumoconiosis and silicosis have been associated with an increased risk of tuberculosis, lung cancer, scleroderma, systemic lupus erythematosus and rheumatoid arthritis in these occupations.

Hypersensitivity pneumonias are occupational diseases of farmers (farmer's lung), compost workers and bird fanciers (pigeon fancier's lung) the inhalation of spores or foreign protein leads to typical symptoms. Farmer's lung was first reported in 1713 and in 1932 Campbell¹⁵ described the condition in dairy farm workers handling mouldy hay. Between 0.4% to 0.7% of the farming community in the United States has been found to be affected by this condition.

In the UK the incidence is reported to be 420-3000 cases per 100,000 workers, with a fatality rate of up to 20%. Improvements in farming techniques have reduced the incidence of disease over the years. The causative organisms are listed in Table 1.

Musicians are also at risk of contracting infections from their instruments. Hypersensitivity pneumonitis and death from a condition known as 'Bagpiper's Lung' has been recorded in players of this instrument. It is caused by the inhalation of fungal spores colonising the bag of the instrument. Similar conditions have been reported involving saxophone and trombone players. Such occurrences highlight the need for regular cleaning of musical instruments.

A case of anthrax due to the release of spores from the skin (hide) of an African drum occurred in Florida, USA in 1974. Subsequent cases have been recorded in Scotland (2006), New York (2006), Connecticut, USA (2007) and London in 2008.^{16,17} The cases in Scotland and London subsequently proved fatal.

Farmer's lung	Exposure to spores of <i>Trichosporon asahii</i> and <i>Trichosporon mucoides</i>
Compost workers	Exposure to spores of <i>Saccharopolyspora rectinurgula</i> and <i>Eumotium amstelodarii</i>
Pigeon and bird fancier's lung	Inhalation of bird proteins (droppings, feathers)

Table 1. Hypersensitivity pneumonias.

CONCLUSIONS

Many occupations and pastimes are now recognised as being hazardous, but not all of the hazards were immediately obvious. It has often required an accumulation of many cases before the dangers are identified, and the necessary control measures put in place. Laboratories use many dangerous chemicals but are not unique in being a hazardous working environment, as specific occupations have been shown to have specific risks or illnesses. We are, however, now more aware of the dangers and how to regulate and minimise the risks.

This article is based on, and expands, the subject of the IBMS History Committee posters exhibited at the Biomedical Science Congress, held at the International Convention Centre, Birmingham, in September 2019. The five posters may be viewed and downloaded as PDF files from the IBMS website (www.ibms.org/historyposters/occupational_health/).

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