MINERAL OIL CANCER IN BRITAIN

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History of mineral oil cancer in Britain

Cancers of the skin, in particular the skin of the scrotum in men, attributable to exposure to mineral oils first began to be observed in the latter half of the 19th Century. The first recorded case of cancer of the scrotum due to exposure to mineral oil was in a Scottish shale-oil worker. This was in 1876. However, S.A. Henry [1] who wrote a book on scrotal cancer (published in 1946) found a case of death from scrotal cancer in a man who oiled machinery in a cotton spinning mill. The man died in 1875.

Between 1875 and 1950 there occurred a major epidemic of scrotal cancer in cotton spinners, mainly in the Lancashire area of Britain.

Mineral oil was officially recognised as a cause of skin cancer in 1914, when it was added to the schedule of causative agents under the Workmen's Compensation Act. Skin cancer attributable to exposure to mineral oil became a notifiable disease under the Factories Act in 1920. In 1953, it was made illegal to use unrefined mineral oil for the lubrication of cotton spindles. An acid-refined white oil had to be used.

Today in Britain there is much concern about the high risk of skin cancer among men who work with automatic lathes in the Engineering Industry. "Tool-setters" are at especially high risk. In 1968, in an action against her husband's former employer, the widow of a "tool-setter" who died from scrotal cancer was awarded £10,000 damages in the High Court.

There is also a fairly high risk of skin cancer amongst Jute workers [2, 3] and a less marked risk associated with a variety of other occupations which entail lesser contact with mineral oils.

This short history is summarized in Table 1.

Scrotal cancer in Cotton Spinners

Between 1920 and 1943, a total of 3333 cases of industrial skin cancer were notified in Britain. Nearly half of these were due to shale oil or mineral oil and most of these were in cotton and textile workers. Thus 1303 cases of skin cancer, in 824 of whom the scrotum was affected, were in cotton or wool spinners. By the time that it was made mandatory to use acid-refined white mineral oils for lubricating cotton spindles, that is to say, 1953, the cotton industry in Britain was already a dying one. Thus it is unlikely that this regulation had much effect.

Mineral oil reached the scrotal area because (i) the worker had to lean over a spindle that splashed him with oil in the scrotal area. (ii) he put oil-soaked rags in his overall pockets. (iii) both industrial and personal hygiene standards were low.

A few women cotton spinners developed cancers of the skin in the vulva [1]. It seems likely that the scrotal and vulval skin are especially susceptible to the induction of skin cancer because they have abundant sebaceous glands.

Skin cancer among Jute workers

Jute was introduced into Dundee in Scotland from India between 1830 and 1840. Jute is a very harsh fibre and has to be softened before it can be spun. During the 19th century softening was mainly achieved by treatment with an emulsion of whale oil or seal oil and water. This process is called "Batching". From about 1880 onwards mineral oils began to replace the whale and seal oils, mainly because they were cheaper. By 1920 99% of the oil used was mineral oil.

The requirement to use acid-refined mineral oil for the lubrication of spindles in the textile industry did not apply to the jute industry and was ignored. A high incidence of skin cancer in Dundee jute workers was reported in 1954 [2].

In 1965, my colleague, Dr. J.S. Harington, discovered that when asbestos is transported or stored in jute bags, residual mineral oil in the jute is adsorbed by the asbestos. Harington wondered whether the carcinogenicity of asbestos might be due to adsorbed mineral oil. Accordingly, Harington and myself showed that oil extracted from asbestos may initiate tumour formation in mouse-skin subsequently exposed to the tumour-promoting agent, croton oil[4].

In 1967, we tested a sample of mineral oil in current use for the "Batching" of Jute and found it to be potently carcinogenic for mouse-skin[5]. As a result of these findings, we understand that a higher quality (i.e. more highly refined) oil is now being used.

Mineral oil cancer hazard in the Engineering Industry

Today, in Britain, the greatest hazard of cancer from mineral oils relates to their use as lubricants and coolants in metal-cutting operations. Many metal parts, such as nuts, bolts, screws and washers, are produced in fully automatic lathes, in which the cutting edge is lubricated and cooled by a continuous stream of a low viscosity mineral oil, known as a cutting oil. The men who operate these machines are called "tool-setters" because the main part of their job is to adjust the cutting edge, which is the "tool", and to replace it when it gets blunt.

Since about 1950 there has been a slowly rising incidence of skin cancer, in many cases affecting the scrotum, amongst "tool-setters" and "automatic lathe operators".[6, 7, 8, 9, 10] In the Birmingham area of England, there are now occurring between 10 and 20 new cases of scrotal cancer among metal cutting operatives each year. The award in 1968 of £10,000 damages to the widow of a tool setter has had a dramatic effect on the attitude of factory owners and managers to the problems involved.

Clinical picture of skin cancer from mineral oil

Henry [1] reviewed nearly 600 cases of scrotal cancer attributable to exposure to mineral oil. Ages at death ranged from 28 to 82 with a mean of 58-59. A history of exposure to oil for 30-50 years was common and cases were rarely seen where there had been less than 16 years of exposure. In some instances cancer appeared several years after exposure to mineral oil had ceased and a man had moved to a non-hazardous occupation.

The disease usually begins as a keratotic wart which sooner or later becomes an ulcerating epithelioma. The rate of progress and growth vary widely. Sometimes a tumour is clearly malignant from the start. For reasons that are not well understood scrotal cancers have a worse prognosis than cancers of the skin of the hand or forearm. Metastasis to the inguinal lymph nodes tends to occur early. It is therefore essential that men who are exposed to mineral oil are told to consult a doctor as soon as they notice any lesion of the skin of the scrotum. Men often delay consulting a doctor about scrotal disease because they fear that it may be a manifestation of venereal disease or that they might be falsely accused of having contracted venereal disease.

It is important to realise that cancer is only one of several effects of mineral oil on the skin. An earlier effect is oil acne which results from plugging of hair follicles with debris following damage to sebaceous glands. Persons with dark, hairy, greasy skins are especially susceptible to this effect of mineral oil. However, there is probably no relation between susceptibility to oil acne and susceptibility to skin cancer from mineral oil.

The clinical features of skin cancer due to mineral oil are summarized in Table 2.

Prevention of mineral oil cancer

The following measures have been proposed: [6, 11]

(i) Better protective clothing

(ii) Warning workers of hazard and of need to report skin lesions

(iii) Regular medical inspection to enable early medical treatment

(iv) Provision of washing facilities in factories

(v) Higher standards of personal hygiene

(vi) Use of safer oils

The viscosity of cutting oils is such that it is difficult to devise impervious protective clothing. Oil seeps through even small holes. Protective clothing tends to be uncomfortable to wear. Oil tends to drip off from protective aprons on to shoes. Therefore it is essential that protection is based on frequent changes of overalls. Overalls should be washed not less often than twice per week (preferably daily) by a method that effectively removes mineral oils. Oil-soaked rags should not be put in pockets especially trouser-pockets. Overalls should be designed to prevent this being done.

Of all the measures proposed, perhaps the most important is the raising of standards of personal hygiene. Some men are 'clean' workers. They remove the oil from the surfaces of machines before they lean across them. Others are dirty and get covered in oil very soon after they start work each day. Careful washing and bathing to remove all traces of oil from the skin immediately after work each day is probably a most effective preventive measure.

The mechanism by which mineral oils cause cancer is not fully understood. However, several known carcinogens have been detected in the aromatic fraction of cutting oils. [12, 13]. Also, aliphatic substitutes such as dodecane have been shown to enhance the carci

(i.e. exert a co-carcinogenic effect). Sulphur[15] and certain phenolic compounds[16] which may be present in blended cutting oils have also been shown to have co-carcinogenic activity. Table 3 summarizes our knowledge with regard to the presence of carcinogens and co-carcinogens in blended cutting oils.

It is possible by treatment of oils with acid (= acid-refining) to reduce the concentrations of unsaturated aromatic compounds and thereby to reduce the concentration of known carcinogens. This is how white mineral oils are produced. Unfortunately white mineral oils do not have the viscosity characteristics that are required for metal cutting.

It is also possible to remove certain aromatic compounds by solvent extraction. By this means it is possible to make safer oils that are suitable for cutting purposes. Solvent-refined oils cost more than unrefined oils.

For some metal-cutting processes oil-water emulsions (soluble oils) can be used. Since these contain only some 10% of mineral oils they are almost certainly safer to use, especially if based on solvent-refined oil. The use of soluble oils is also cheap. Unfortunately soluble oils are not suitable for all automatic lathes.

At present it is not certain to what extent carcinogens are actually formed if oils are 'overheated' during metal-cutting operations.

Possible hazard of cancers of the respiratory and gastrointestinal tracts from oil mist

Many metal-cutting operations lead to the generation of a fine oil-mist into the air which lathe-operators inhale.

The lung is fairly efficient in ridding itself of small oil droplets. Nevertheless, there may theoretically be a lung cancer hazard from exposure to oil mist.

Recently Dr. J. Waterhouse and his colleagues[17] reported that among men who have recovered from successfully-treated scrotal cancer there is an excessive risk of development of a second primary cancer, not only of the skin but also of certain internal sites, including the lung and gastro-intestinal tract. The excess is statistically significant. More direct studies[18] of the effects of oil mist on the lungs of workers have not always indicated the induction of lung damage.

Summary and Conclusions

The tragedy of the present epidemic of scrotal cancer among 'tool-setters' in the Birmingham area of Britain is that it should never have happened ! If the lesson provided by the massive epidemic of scrotal cancer in cotton spinners that began in the 1870's had been learned, men in the engineering industry might not have been so heavily and unnecessarily exposed to carcinogenic cutting oils during the last 30 or 40 years.

A serious aspect of the situation is that the modern way of life depends on men being exposed occupationally to carcinogens, such as mineral oil and asbestos. Complete protection from exposure to such materials is impossible. The future, therefore, must be one of compromises, whereby exposure to such substances is reduced to levels at which the health risk to individual workers as minimal. In addition, those working with hazardous substances should be both fully warned of the dangers and fully instructed as to how to minimise the risks to themselves. The institution of systems of regular medical examination is likely to be of great benefit. In the case of cancer of the scrotum from mineral oil, it is established that early detection by routine medical inspection is frequently life-saving.[10]

Table 1 : History of mineral oil cancer in Britain

1875	:	First death of cotton spinner from cancer of the scrotum.
1876	:	First case of scrotal cancer in a Scottish shale oil worker reported.
1880 - 1940	:	Major epidemic among cotton spinners.
1914	:	Mineral oil as a cause of skin cancer recognised under Workmen's Compensation Act.
1920	:	Skin cancer from mineral oil made notifiable under Factories Act.
1950	:	First cases of skin cancer in metal machinists exposed to cutting oils reported.
1953	:	White mineral oils made mandatory for lubricating cotton spindles.
1968	:	Widow of "Tool-setter" awarded £10,000 damages.

Table 2 : Some Clinical Features of Mineral Oil Cancer

1.	Skin of scrotum, hands, forearms and thighs are commonly affected.
2.	Age at death ranges between 28 and 82 years (mean = 59).
3.	Minimum exposure period is approximately 16 years.
4.	In most cases exposure period lies between 30 and 50 years.
5.	Cancer may arise many years after exposure has ceased and a man has moved to another occupation.
6.	Disease may begin as a precancerous keratotic wart which progresses to epithelioma or a lesion may be malignant ab initio.
7.	There is probably no relationship between susceptibility to oil acne and susceptibility to skin cancer.
8.	Scrotal cancer has a poorer prognosis than skin cancer at other sites.
9.	Shyness or fear that scrotal cancer is a manifestation of venereal disease may delay diagnosis.

Table 3 : Carcinogens and Co-carcinogens in a Standard Blended Cutting Oil

- Blended Cutting Oil
  - I Distillate from Crude Oil
    - A Paraffins*
    - B Naphthenic compounds
    - C Aromatic compounds**
  - II Sulphurized sperm oil*
  - III Additives e.g. phenolic compounds*

** KNOWN CARCINOGENS

Certain aromatic compounds with 4 - 6 fused benzene rings

* KNOWN CO-CARCINOGENS

(a) Certain aliphatic compounds e.g. Dodecane

(b) Sulphur

(c) Certain phenolic compounds e.g. Phenol itself

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