Prolonged exposure to sunlight (especially ultra-violet light) may produce skin changes that terminate in cancer. This was noted by: Unna (1896), under the name “Seemannshaut,” a condition common among sailors; Lenthal Cheatle (1908-1909); Young and Russell (1926); Dubreuilh (1907, 1915, 1920, 1925); Bellini (1909); Hyde (1906), Corlett (1915) and McCoy (1920); Molesworth (1927); Lawrence (1928); Colquhoun (1927); and Cheatle (1925). These scientists investigated the roles of race, occupation, environment, sunlight, and quartz light therapy in the development of skin cancer.

In 1928, in the Lancet, Dr. George Findlay reviewed the work performed up until that time and also reported his own findings.

Experimental Procedure

In order to determine experimentally whether ultra-violet light had any carcinogenic action on the skin, a series of experiments were carried out on mice.

The source of ultra-violet light was a quartz mercury-vapour lamp manufactured by the Hewittic Electric Company, Limited, of Hersham, Surrey. The lamp is fitted with a standard Y2 Uliarc burner, functions on 200-300 volts, and has an amperage of 3.5. The spectrum of the mercury arc is said to cover a range from 2,000 A.U. in the ultra-violet to 10,140 A.U. in the infra-red; it is, however, deficient in red and infra-red rays. The mice, which were of the albino variety, were at first epilated with a solution of sodium sulphide on an area of the back between the shoulders, as is usually done in applying tar for carcinogenic purposes. After from one or two months exposure, there was no further need of any depilatory.

The mice were exposed to the light by placing them in a sanitary bin 13 in. in diameter, fitted with a false bottom of perforated zinc. The mercury-vapour lamp was placed on a wooden frame which fitted over the top of the bin in such a way that the rays of the lamp were directed downwards into the bin, the false bottom of which was 18 in. distant from the light.

In the first two experiments, the effect of combining ultra-violet light with a known carcinogenic agent, such as tar, was investigated. In the last experiment the effect of ultra-violet light alone was studied.

**Expt. 1.**—Thirty albino mice were tarred twice a week over a small area of the back with a known carcinogenic tar. Ten of the mice served as controls. The other 20 mice were exposed for two minutes four times a week to the mercury-vapour lamp...cancer of the skin occurred more rapidly in those mice which were treated with tar and ultra-violet light than in those treated with tar alone.

Excerpted by permission from Lancet 2:1070-1073, 1928.
The following is a brief account of the growths occurring in the tumour-bearing mice:

Mouse 12. A small papilloma with considerable ulceration at the base; there was no penetration of the panniculus carnosus. The mouse died 18 days after the first appearance of the growth.

Mouse 13. A small wart-like growth first appeared on the anterior aspect of the pinna of the right ear. This grew slowly, finally ulcerating through on to the posterior surface of the ear. Ten days after the appearance of the ear tumour a small papilloma was noted on the back; a second papilloma appeared a week later. These papillomata at first grew slowly; then after some six weeks the skin around the papillomata became thickened and a large horny growth resulted. The tumour was operated on and autoplasts made. Unfortunately, the tumour was infected and both autoplasts ulcerated out. At death, however, the left axillary gland was found to contain a metastasis. Histological examination of the tumour showed a cancroïd very similar in character to those commonly produced in the mouse by tar painting.

Mouse 14 had a very similar history to that of No. 13. Three papillomata first appeared on the back; after progressing slowly for a time they took on active growth forming a large horny mass; in the meantime a warty growth had appeared on the anterior aspect of the right ear, gradually involving the whole of the pinna. Ten weeks after the first papilloma had been noted on the back a single small papilloma appeared on the dorsum of the pinna of the left ear. The growth on the back was operated on and autoplasted with subsequent growth. The tumour on the right ear had histologically the appearance of an epithelioma with keratinisation and cell nests. The superficial portion of the tumour on the back had a similar appearance, but the deeper portion had the characteristics of a small spindle-celled sarcoma.

Mouse 15. Three small papillomata first appeared on the skin of the back. The skin surrounding these growths rapidly thickened, forming a rounded firm
mass about the size of a threepenny-piece. The tumour was removed at operation and two autoplasts made in the mouse. Both the autoplasts grew slowly. Six weeks after the operation the mouse was killed and one of the autoplasts was transferred to normal mice. Growth occurred in one in 20 of these mice. Histologically the original growth showed in the more superficial areas down-growth of epithelium with typical cell-nest formation and keratinisation. The deeper part of the tumour, however, had a more sarcomatous appearance, consisting of large spindle-shaped cells. It was possible, however, to distinguish all gradations of cell types from the typical epidermal cells of the cell nest to typical spindle cells. The question therefore arises as to whether this tumour is to be regarded as a carcinoma or a carcinosarcoma. The same problem has arisen in the interpretation of many tar tumours. In the autoplasts the prevailing cell was of the large spindle-shaped type; keratinisation was absent.

**Mouse 18.** A small papilloma first appeared on the anterior aspect of the pinna of the right ear. Subsequently the whole ear was involved, the cartilage of the ear being disorganised.

**Mouse 19** had three papillomata on the back and one small one on the left ear. **Mouse 20** had two small papillomata on the back. In neither of these animals was there evidence of penetration through the panniculus carnosus. Of the seven tumour-bearing mice, therefore, three have developed papillomata, while four have had tumours which are of a definitely malignant type. In two of these four mice the malignant growths have been multiple.

**Discussion**

The experimental evidence thus brought forward shows that mice exposed to the mercury-vapour lamp for a period of not less than eight months develop either simple papillomata or malignant epitheliomata. Further, when a known carcinogenic agent is at work on the skin, exposure to ultra-violet light for a comparatively short period may lead to the rapid development of malignant new growths. These experiments, therefore, are in favour of the hypothesis based on clinical evidence that in man exposure to ultra-violet light plays an important part in the aetiology of cancer of the skin of the face, neck and hands.

**Conclusion**

1. By exposure of mice to ultra-violet light for a period of not less than eight months it is possible to produce papillomata and malignant epitheliomata of the skin.

2. When mice are tared and exposed to ultra-violet light at the same time, the period necessary for the induction of cancer is shorter than when either tar or ultra-violet light alone is employed.

3. A series of mice tared for one month failed to develop cancer, but when tared and exposed to ultra-violet light for the same period three mice developed malignant growths.

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