CUTTING OILS AND SQUAMOUS-CELL CARCINOMA

PART I: INCIDENCE IN A PLANT WITH A REPORT OF SIX CASES

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The occurrence of skin cancer in machine operators is of interest because of its possible relation to exposure to petroleum products, chiefly the cutting oils. When, therefore, six cases of squamous-cell carcinoma of the skin have become known at a single machine-operating plant the cases are considered of sufficient importance to warrant reporting with some observations on both clinical histories and incidence rates during the last 10 years.

The plant concerned has been in operation since before 1920. Both manual and automatic machines of different types have been used. A medical centre is maintained in the plant with a part-time physician.

It is not known if the cases reported represent all those which occurred during this period. Records are not available covering the retired, transferred, or terminated workers. There is also a possibility that cases existed for which there are no available records.

Details of these six cases (Cases 1 to 6) and of one case of skin papilloma (Case 7) are given below.

Case Reports

Case 1.—This man, born in 1896, started at the plant in 1920 as the operator of a horizontal broacher which splashed oil towards the lower abdomen of standing operators. It had been his main employment. In January, 1950, he noticed a slight chafing on the right side of the scrotum which subsequently became infected. This condition, however, was not reported to the plant physician until nearly 12 months after the initial symptom. By this time there was an indurated ulcer about 1½ in. in diameter on the right side of the scrotum with some enlargement of the lymph glands in the right groin. He was admitted to hospital and the lesion was widely excised in January, 1951. The histological diagnosis was squamous-cell carcinoma, grade III. The lymph glands in the inguinal and femoral regions were bilaterally dissected at a second operation and biopsy of these glands showed no evidence of metastatic growth. This man is still at work as a supervisor.

Case 2.—A man, born 1896, was first employed at the plant in 1935 and had operated various machines. In September, 1950, he suffered a minor laceration on the back of the right hand. A swelling, thought to be caused by an embedded steel fragment, developed at this site. It was excised about a month after the original injury. Routine biopsy examination revealed squamous-cell carcinoma, grade I. This man is still at work at the plant.

Case 3.—For 22 years this man, born in 1900, had worked as a gear cutter in another plant with similar working conditions. In 1932, while employed at this plant, he had dermatitis of both forearms. Since this time he has suffered from dermatitis of both forearms intermittently. In 1947 he transferred to the present plant. For a short time he operated automatics and later various other machines. In September, 1950, several infected papules appeared on the right forearm. One did not respond to treatment but remained as a swelling. The plant physician referred him to a dermatologist for consultation; the clinical diagnosis was epithelioma. The lesion was excised in November, 1950, and the histological diagnosis was squamous-cell carcinoma, grade I. In June, 1953, he was admitted to hospital because of traumatic pneumonitis following an injury to the chest wall. During this admission several growths of the lower abdomen and thighs were noted. One of these, a growth on the right side of the abdomen, was removed and when examined microscopically was found to be squamous-cell carcinoma, grade I. This man is still at work.

Case 4.—This man, born in 1905, began work in 1929 on the automatic machines. He had been, however, mainly occupied in other machine work. In November, 1942, he noticed a swelling on the right forearm which gradually increased in size. This was excised and microscopic examination revealed epidermoid carcinoma (low grade). In 1944 he began to suffer from recurrent dermatitis of both forearms. A dermatologist reported his condition in June, 1944, as follicular keratosis with a developing ulceration of the left forearm, clinically malignant. Radium treatment controlled this lesion satisfactorily but in follow-up visits some enlargement of

the lymph glands in the left axilla was observed. A radiologist advised excision of these glands. This was done in November, 1944. No secondary growth was observed in the dissected lymph glands. Upon recovery he returned to his former work. In 1952 a further lesion occurred on the right forearm. This was excised in December, 1952, and diagnosed as squamous-cell carcinoma, grade I. He is still at work at the plant.

Case 5.—In 1924, this worker, a man born in 1894, began as an operator on the automatic machines, later becoming a set-up man, and eventually a supervisor. In May, 1953, he reported to the medical centre with dermatitis involving both wrists and forearms. Shortly afterwards a warty growth appeared on the right wrist. This was excised in August, 1953. Microscopic examination revealed it as squamous-cell carcinoma, grade I. A second lesion occurred and was removed from the left forearm in November, 1953, with a similar histological diagnosis. He is still at work.

Case 6.—This workman, born in 1902, started at the plant in 1935 as an automatic machine operator. He suffered from an oil dermatitis in 1944 but it cleared without trouble. In July, 1952, he was seen with multiple keratoses of both forearms. These were considered clinically as precancerous lesions and removal was recommended. Several were excised in July, 1952, and were described histologically as presenting the picture of senile keratosis. Since the first excision many keratotic lesions have been removed by excision, desiccation, curettage, or x-ray treatment. In October, 1952, a lesion removed from the left forearm showed evidence of low-grade malignancy (squamous-cell carcinoma, grade I). Numerous lesions removed subsequently from both forearms were described microscopically as oil keratosis. This man died suddenly at work in November, 1954, of heart disease.

Case 7.—This man, born in 1891, gave a history of almost unbroken employment as a machine operator since 1907. In 1925 he started to work at this plant as a set-up man on automatic machines. In May, 1945, he was seen by the plant doctor with an infected oil dermatitis of both forearms. In July of that year a consultant noted many hyperkeratotic lesions on both forearms and on the scrotum. There was a cutaneous horn on the dorsum of the right hand. At that time some of the lesions were described as potentially malignant. In October, 1945, four such lesions were excised, two from the right forearm, one from the left forearm, and one from the scrotum. Microscopic examination revealed no definite malignant change. One lesion from the right forearm was described microscopically as a papilloma and the lesion from the scrotum was described as having papillae which dipped very deeply into the corium. This workman returned to the plant after removal of the lesions. He was then given work away from oil. Despite this, hyperkeratotic lesions continued to develop and he left the plant in 1947 with the clinical diagnosis of chronic occupational dermatitis. He has been seen

regularly since 1947 with a persistent dermatitis and numerous hyperkeratoses over both forearms and hands.

Observations on the Case Histories

From the data presented in Table 1 it can be seen that the age at onset of carcinoma ranges from 37 to 59 years with an average of 51.

The length of employment in the plant varied from three to 31 years. The workman who had worked only three years should rightly be excluded, since he had been similarly exposed before. When this is done the years of exposure of the remaining five cases varies from 13 to 31 years with an average period of 21 years.

TABLE 1
SUMMARY OF DATA ON PLANT CASES

Case	Machines Operated	Age at First Lesion	Plant Exposure (Years)	Original Site	Subsequent Carcinomata
1	Broacher	55	31	Scrotum	
2	Various	54	15	Right hand	
3	Various	50	3*	Right forearm	Abdominal wall (1953)
4	Various and automatics	37	13	Right forearm	Left forearm (1944)
5	Automatics	59	29	Right wrist	Right forearm (1952)
6	Automatics	50	17	Left forearm	Left forearm (1953)
7	Automatics	54	20	Right forearm	

* This man worked 22 years at similar work in previous employment.

The site of the first lesion in these cases is interesting. The exposed skin of the hand and forearm is involved in all cases except one which is of the scrotum. It is interesting also to observe that the right side is involved as the site of the first lesion in five of the six upper limb cases.

Three of the cases of carcinoma and the one case of papilloma did most or all of their work on automatic machines. Automatic machine workers comprise only about 5% of male machine operators.

The Incidence Rate

It is important to realize that in this study of the incidence of skin carcinoma the derived rates are based on only six reported cases. Furthermore, it was decided arbitrarily to study the reported cases in relation to the male population of the plant for a 10-year period from 1945 to 1954. The inclusion of Case 4 is warranted because of the occurrence of a new carcinoma in 1952.

The male workers in the plant may be classified in three ways: (1) The total number employed: the mean yearly population was taken as the average of the 12 monthly totals. Seasonal fluctuations were

not of importance in this plant. (2) The number of machine operators: the figures were obtained and handled similarly. (3) The number of machine operators employed 15 years or more: figures for these were obtained by year.

The population data for the plant are recorded in Table 2 under these three headings.

TABLE 2
PLANT POPULATION DATA 1945-1954

Year	Total Males Employed	Male Machine Operators	Male Machine Operators Employed 15 Years or More
1945	1,104	648	37
1946	1,133	687	37
1947	1,228	598	42
1948	1,351	670	47
1949	1,458	734	70
1950	1,385	701	107
1951	1,654	818	116
1952	1,498	833	127
1953	1,392	627	132
1954	1,053	543	132
Totals	13,256	6,859	847

If the six reported cases of squamous-cell carcinoma involving the limbs and scrotum are related to the total number of males employed from 1945 to 1954 the incidence rate for the plant can be expressed as 45.3 per 100,000 (standard error 18.4). Should these cases, however, be related to the machine operators only, the incidence rate would be 87.5 per 100,000 (S.E. 35.7). Five of the six observed cases occurred in machine operators employed for 15 years or more.

A comparison of the incidence of skin cancer in workers in this plant with that occurring in workers in other machine-operating plants would be of interest. Unfortunately, such figures are not

available. It is possible, however, to compare the rate with that of North American males noted in Table 3. Particular attention has been given, whenever possible, to similar age groups and sites.

Included in this Table are some figures published by Jenkins (1948) on the occurrence of epitheliomata in gas and tar production workers in Great Britain. The six plant cases may be compared with eight cases, which would be expected if the crude incidence rate for Jenkins' gas and tar production workers were applied to the total number of male workers at the plant. Similarly, four cases would be expected if that rate were applied to the machine operators. If the incidence rate for carcinoma of the skin involving limbs, trunk, and scrotum in gas and tar production workers were applied to the same two groups above, one would expect three and two cases respectively. The differences between the observed number of cases and the expected numbers thus derived are not significant.

The Connecticut figures (Macdonald, 1948) reveal that 30.8% of the 2,094 male skin cancer cases reported from 1935 to 1946 occurred in the age group 30 to 59. The site distribution of these cancer cases, as well as the unpublished figures from Middlesex County and our cases are given in Table 4.

Cruickshank and Gourevitch (1952) found the scrotal and upper extremity sites to be of about equal incidence in males in Birmingham. Henry (1947) found the scrotal site to comprise 52.5% and the hand and forearm site 22.5%. His cases included many from the cotton industry. The hand and forearm site is very prominent in the plant under discussion.

TABLE 3
COMPARISON OF VARIOUS STUDIES OF SKIN CANCER INCIDENCE IN MALES*

Region	Group	Year	Cases Reported	% Biopsied	Rate per 100,000 Males	
					Skin of Limbs, Scrotum, and Trunk	All Skin
Southern United States	Birmingham, Ala.†	1948	244	66	27.7	146.7
	Dallas, Texas†	1948	329	64	23.5	138.2
	New Orleans, La.	1947	201	72	17.7	108.0
	San Francisco, Calif.	1947	683	70	16.3	95.0
	Atlanta, Ga.†	1947	234	41	4.6	35.8
Northern United States	Pittsburgh, Pa.	1947	284	83	8.6	38.7
	Philadelphia, Pa.†	1948	351	86	7.4	36.0
	Detroit, Mich.†	1948	311	74	6.8	30.0
	Chicago, Ill.†	1947	489	61	4.5	26.2
	Connecticut (Macdonald, 1948)	1940-46	‡	74	5.9	23.5
Ontario, Canada	London and Middlesex County (Sellers and others, 1950)	1939	44	52	—	71.0
	London and Middlesex County§	1953	51	93	—	60.7
	London and Middlesex, Age 15-64§	1953	10	90	1.8	18.4
Great Britain	Gas and tar production workers (Jenkins, 1948)	1933-42	22	73	24.8	60.7

* Source is the United States Federal Security Agency (1950-1952) unless otherwise noted.

† White males only.

‡ 2,094 male cases from 1935-46.

§ Unpublished figures; 1953 estimated male population 84,000.

TABLE 4
PERCENTAGE DISTRIBUTION OF SKIN CANCER BY SITE

Group and Year	Cases Reported	Upper Extremity	Lower Extremity	Trunk and Scrotum	Multiple Sites	Other Sites
Connecticut (1935-1946) (Macdonald, 1948) ..	2,094	9.6	3.4	8.7	4.0	74.3
London and Middlesex (1953) (Unpublished)	202*	1.5	3.5	4.5	2.0	88.5
Our Series (1945-1954)	6	83.3	—	16.7	—	—

* Prevalent skin cancers, including 51 new cases but excluding five melanomata.

In England and Wales, 340 cases of mineral oil epitheliomatous ulceration were recorded in the 10 years 1943 to 1952 according to the annual reports of the Chief Inspector of Factories (Ministry of Labour and National Service, 1943-52). A complete breakdown of these cases by occupational group is not given in either the 1943 or the 1945 report. In the remaining eight reports, however, some 16 cases can be found which may be classified as affecting machine operators. These would probably correspond to our plant cases. A large proportion of the 340 notifications are from the cotton industry. It must be borne in mind, however, that notifications to the Chief Inspector of Factories are incomplete. Cruickshank and Squire (1950) reported a case of scrotal carcinoma in an automatic machine operator. In a study of the United Birmingham Hospitals records from 1939 to 1948 they found 34 workers with scrotal cancer, six of whom were machine operators and a further six were exposed to oil in the engineering industry. Cruickshank and Gourevitch (1952) in a continued study of hospital records noted 44 cases of epithelioma of the hands and forearm and 34 of the scrotum between 1941 and 1950. Of these, 16 hand and forearm cases and 14 scrotum cases occurred amongst metal workers. The latter 30 cases, occurring in the Birmingham area over a 10-year period, may be compared with the six cases reported here during a similar period.

The crude incidence of skin carcinoma in the total number of male plant workers and in machine operators (based on six cases over 10 years at the plant) is not remarkable compared with that of all other groups noted. But when allowance is made for age, for the site affected, and for the geographic region, these observations suggest a possible relationship between the occurrence of squamous-cell carcinoma and long-continued occupation as a machine operator. Exposure to cutting oil is likely to be the important factor.

Summary

Six histologically verified cases of squamous-cell carcinoma and one of papilloma in workers of a single machine-operating plant are reported.

Three of these cases had four new occurrences of squamous-cell carcinoma (three verified by biopsy).

The age at onset of the six cases was from 37 to 59 years with an average age of 51.

The average period of exposure for five of the six cases was 21 years (Case 3 excluded).

Automatic machine workers, who comprised about 5% of the machine operators, made up from one-third to one-half of the cases of carcinoma.

The exposed skin of the hand and forearm constituted five of the six cases of carcinoma.

Because of the possible relationship suggested above, two of the cutting oils in use were tested experimentally for their carcinogenic effect.

This study was undertaken by Drs. J. P. W. Gilman and S. Vesselinovich and will be reported separately as Part II of this contribution.

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