OIL FOLLICULITIS

A STUDY OF 200 MEN EMPLOYED IN AN ENGINEERING FACTORY*

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Occupational skin disease is a problem of major importance in the engineering industry. Little is known about the occupational distribution of oil folliculitis and its varying degrees of severity. This investigation was undertaken in an attempt to discover which occupations are at risk and why.

The study was conducted at an engineering factory where 200 men, whose daily work brought them in contact with mineral oils, petroleum products, or greases, were surveyed. The survey comprised a personal interview and clinical examination. The object was to determine the severity of the folliculitis and the nature of certain environmental factors which might be associated with the development of this condition.

It was found that in the occupations of capstan lathe operator and automatic lathe operator there was a significantly higher proportion of men with the more severe degrees of oil folliculitis. It was also demonstrated that in these occupations men were exposed to oil to a significant degree. The apparent inefficiency of personal hygiene as a preventive measure was thought to be due to insufficient cleansing so that oil was not properly removed from the skin. This type of occupational skin disease will remain prevalent until machines can be so designed as to eliminate or reduce contamination of the workers' skin by oil.

Occupational skin disease (occupational dermatitis) affects workers in many different jobs, and is caused by numerous agents used in industry. The engineering industry is one of the largest, and the majority of its employees are exposed to contact with mineral oils, petroleum products, and greases. These oils are probably the commonest causes of occupational skin disease. Oil folliculitis seldom causes absence from work, but it is possible that prolonged exposure to oil may result in epitheliomatous change. It is clear from published work on occupational skin disease that the potentially serious nature of the problem is appreciated by legislators, employers, and dermatologists.

Aetiology of Oil Folliculitis

The main points to be evaluated are (1) the skin, (2) the oil, (3) the occupation, and (4) personal hygiene. The two main theories of aetiology which

have been advanced are: (a) Schwartz's (1941), the "mechanical" theory, which attributed the development of the condition to the follicular openings becoming plugged with oil and dirt. This leads to retention of glandular secretions and stimulates the formation of keratin. Comedones subsequently develop on a background of inflammatory reaction. (b) Whitwell's (1943) is the "chemical" theory, based on experimental work, in which he found that the application of cutting oil to the papules of oil folliculitis increased their size; protection from oil led to a diminution in size. From this Whitwell concluded that chemical irritation was the primary cause of the condition. In his opinion, this theory explained the marked difference in the relative toxicity of oils; crude cutting oils were found to be much more hazardous than high-grade lubricating oils.

Neither theory is completely acceptable. Schwartz disregards the composition of the oil as a factor of any importance, and Whitwell, who seems nearer to the truth, appears to suggest that the irritant effect of cutting oil is purely a surface one. However, his chemical theory merits further study,

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especially in relation to O'Brien's work (1950) on the mechanism of poral closure. O'Brien's investigations were mainly concerned with *miliaria rubra* and the pathology of the sweat pores, but some of his conclusions may well apply to the pilo-sebaceous follicles. O'Brien suggested that poral closure appeared to be a common reaction of the skin, even in cool climates, and was in many instances misdiagnosed as "heat rash", "sweat rash", "occupational", or "contact" dermatitis. From experimental observations O'Brien concluded that lipoid solvents had a special proclivity to enter and promote inflammation within the sweat pores and pilo-sebaceous follicles. This theory of causation tends to confirm Whitwell's.

The sequence of events in oil folliculitis appears to be (a) an initial chemical irritation of the pilo-sebaceous apparatus, followed by (b) a mechanical blocking of the pores by keratin plugs.

The Skin.—The most vulnerable parts of the skin are the openings of the ducts and follicles, through which chemical irritants may enter. The defences against external irritants are the cells of the stratum corneum, the glandular secretions, and to some extent, autogenous disinfection, which has been studied by Burtenshaw (1948).

The type of skin has also attracted the attention of workers in this field. Alderson (1918) considered that a person whose skin was congenitally defective, particularly in the outer layer, was much more liable to develop occupational skin disease than one with a normal epidermis. Schwartz and Peck (1943) emphasized that individuals with excessive hair on the arms and legs and a greasy skin were more likely to develop acne-type lesions and folliculitis; those with a smooth, hairless skin were less prone to develop comedones.

Several workers, in discussing contributory causes in the development of oil folliculitis or associated conditions, have included conditions vague in terminology, such as personal idiosyncrasy, allergy, and predisposition (Dept. of Scientific and Industrial Research, 1918; Scott, 1922; McLachlan, 1922; and Schwartz, 1941). These terms appear to be confusing, and perhaps it would be simpler to regard them collectively as examples of hypersensitivity. An extract from Schwartz, Tulipan, and Peck (1947) sums up the situation:

"Undoubtedly deficiencies in the defence mechanism of the skin render it more vulnerable to the action of primary irritants, but those having physiological, anatomical, or traumatically inflicted defects of the skin are hypersensitive. Such a hypersensitivity is not specific, and the resulting dermatitis is due to the chemical or physical action of the chemical on that particular portion of the skin."

The Oil.—Oil folliculitis and acne are usually more evident in individuals who work with insoluble cutting oils (Schwartz and Barlow, 1942; Schwartz and Peck, 1943). There has been a tendency to minimize the effects of soluble cutting oil, mainly on the supposition that, because the oil is diluted to 1/40 or 1/50 with water, its tendency to induce oil folliculitis is correspondingly reduced. The range of oils employed in any one factory may be extensive. Thus, the nature of two insoluble and one soluble cutting oils in standard use at the factory where the present investigation was conducted is as follows:—

(a) A is an insoluble cutting oil, comprising a blend of a light mineral oil with 12% sulphurized fatty oil base. The base is essentially sperm oil, carrying 16% of combined sulphur. Sp. gr. at 60°F. 0.898 and viscosity at 70°F. 303 seconds.

(b) B is an insoluble cutting oil, a mixture of low viscosity mineral oil and 11% of a chlorinated fatty oil. Sp. gr. at 60°F. 0.860 and viscosity at 70°F. 31 seconds.

(c) C is a soluble cutting oil, giving a semi-clear type of emulsion with water (1/40 or 1/50). Basic constituents are light hydrocarbon oils, emulsifiers consisting of petroleum sulphonates, and soaps of rosin and fat. Viscosity at 70°F. 150 seconds.

It has been one of the objects of the present investigation to determine whether there is an association between exposure to soluble or insoluble oil and the development of oil folliculitis.

The oils were not sterilized. Each machine has a filter unit built in as part of the oil supply system and there is no regular routine of changing oils. The reason for this is that there is a considerable wastage of oil during machining operations, and the oil reservoir of each machine is topped up several times weekly.

The Occupation.—In a typical engineering factory there is a wide range of jobs concerned with the machining and processing of metals. The types of machines employed are either automatic or under the control of a machine tool operator. In the factory where this investigation was conducted, the machine-shop contained automatic lathes, capstan lathes, centre lathes, milling machines, vertical drilling machines, and grinding machines.

Automatic lathe employees are exposed only to insoluble oils, and operators of the remaining machines may be exposed either to soluble or insoluble oil only, or to a combination of both. The nature of the exposure depends on the type of metal being machined, and the degree of finish required. In practice, it is difficult to assess accurately whether a man has had greater exposure to one or other type

of oil. A few workers, because of their skill and speed, may be engaged exclusively on one particular type of operation which requires only one oil. The majority are exposed to both soluble and insoluble oils, in variable proportion. It has been suggested that the most severe and continuous skin contamination occurs at automatic lathes where a series of operations is performed without removal of the metal (Cruickshank and Squire, 1950). In these machines the work is done at very high speeds, requiring large amounts of coolant (in the author's experience, always insoluble oil), and frequently causing much oil spray to disperse into the environment.

The duration of exposure may be important. Thus, Scott (1922) in a study of paraffin workers expressed the opinion that length of service was of considerable importance in determining the nature of the skin lesions. Pustular dermatitis was often encountered in employees with less than two weeks' service, and epitheliomatous conditions were only found in those with many years of exposure. Whitwell (1943) observed that as short an exposure as two weeks could produce an oil folliculitis, whilst Cruickshank (1950) noted that some of his cases occurred in workers with less than six weeks' exposure.

Personal Hygiene.—A relationship between oil folliculitis and personal hygiene, or rather the lack of it, has been suggested by numerous writers, for example, Lewin (1888), Scott (1922), McLachlan (1922), and Schwartz (1942). The cleanliness of man, machine, and environment must be considered in establishing what relationship, if any, exists between hygiene and the development of oil folliculitis. Cruickshank (1948) showed that skin contaminated with cutting oil, when washed with soap and water so as to be "socially" clean, gave conclusive evidence of unremoved oil when examined under ultra-violet light.

Although there is little experimental evidence of the importance of personal hygiene, it is usually regarded as a factor of some importance in the aetiology of oil folliculitis. Personal hygiene has therefore been studied in the present investigation.

The Prevalence of Oil Folliculitis

In a survey of three large Birmingham factories Cruickshank (1950) reported that over 80% of the employees had oil folliculitis and that men of every age and exposure group were equally affected. There are no other recent British surveys for comparison, but Morris and Maloof (1952) in Massachusetts considered the incidence of cutting oil dermatitis to be as high in 1951 as in 1943, account-

ing for 15% of all industrial dermatoses. Anderson (1953) noted that in California 14,777 cases of occupational disease were reported in 1951; 54% of these were dermatoses, and over 50% of these dermatoses were due to oils, greases, solvents, and chemicals. These studies were not concerned with environmental exposure within the engineering industry.

Klauder (1943) investigated the importance of mineral oils in the causation of certain occupational dermatoses. This is the only survey in which attention was directed to the variable incidence in different groups of machine-tool operators; and also the only one in which the different grades of severity of oil folliculitis were defined. Klauder's series of 527 cases included 45 in which petroleum products were thought to be responsible; in this group 36 workers were considered to have oil folliculitis. This study suggested that certain occupations were more hazardous than others in respect of the risk and severity of oil folliculitis. The majority of the more severe cases had been exposed to oil for at least one year. Apart from this there was no correlation between duration of exposure and degree of oil folliculitis. Some of those with normal skins had been exposed for 20 years, which suggests that there may be a predisposition in some people.

Method of Survey

The survey was designed to assess the relationship between oil folliculitis and some possible contributory causes. In particular it sought answers to these questions: (1) Is one job more hazardous than another? (2) Are the type and degree of oil exposure of importance? (3) Does personal hygiene reduce the risk of oil folliculitis? (4) Is there any danger of malignancy?

The survey was conducted during the period 1956-57 at the Aberdeen factory of the Consolidated Pneumatic Tool Company Limited. In this factory about 550 persons are employed, and approximately 250 of these are exposed to contact with cutting fluids. At the outset it was decided to exclude from the survey female machine tool operators and apprentices. There remained 200 men available for study.

A case-sheet was constructed for each man. On one side of the sheet were recorded particulars of the occupation, previous work history, and home environment. The reverse side contained details of the sickness record and the results of the clinical examination. The survey occupied six months. Each occupational group was surveyed completely before investigation of members of a different group. At interview, information was sought concerning age, duration of exposure, previous history of dermatitis, home washing facilities and method of use, the occupation, the oils used, and preventive measures. Information concerning previous skin history at work was extracted from the sickness record cards and entered on the survey form.

Clinical Examination

The examination was confined to the extensor surfaces of the forearms from elbow to wrist. Before examination these surfaces were washed with soap and water. As well as naked-eye inspection, the skin of each arm was subjected to close scrutiny with a Wood's lamp. An original intention had been to attempt to correlate the intensity of fluorescence on the skin with the degree of oil contamination. This, however, proved impracticable, principally because of the large number of men who had been exposed to contamination by mixed oils. The most useful purpose of the lamp was to check the cleanliness of the skin, and a more detailed report of its experimental application is given later.

Workers were classified into various categories according to the severity of the skin lesions! The extensor surface of the forearm was divided into six compartments thus:—

At the time of examination the distribution of comedones and their intensity were marked in a diagram and the papules, or other lesions, were allocated to the appropriate compartments. This method was applied to the entire group of 200 men, and the diagrammatic "skin pictures" were closely studied and graded according to the severity of the folliculitis. Six ratings of severity, 0-5, were decided upon.

A Kodak "specialist" camera was used, with Kodak 0-800 ortho plates. For the series of plates illustrating skin ratings, photoflood lighting was employed, camera distance 42 in. from the skin, aperture $f/32$, exposure time 0.5 second. For the series of plates demonstrating oil fluorescence on the skin, the source of light was a Wood's lamp. Camera distance from the skin 30 in.; a Wratten 2B filter was used. Exposure time 150 seconds, aperture $f/5.6$.

To reduce observer error the survey forms were allocated to the appropriate rating by studying only the diagrammatic representation of the skin condition as

FIG. 1.—Rating 0: completely clean skin with no comedones or other evidence of oil folliculitis (Group A).

FIG. 2.—Rating 2: comedones only, moderate in intensity and involving from three to six compartments in either arm (Group B).

FIG. 3.—Rating 3: moderate comedone involvement of one to six compartments, and not more than three papules or pustules on either arm (Group C).

recorded at the time of examination. The forms, numbered 1-200, were examined in a random fashion on three occasions in one week: no reference was made to the name, occupation, duration, or type of exposure. Consistent accuracy was found in the classification of employees according to their skin ratings.

Results

Occupational Risk of Oil Folliculitis.—The skin ratings were combined in pairs, 0 and 1, 2 and 3, and 4 and 5. This provided three groups, A, B, and C (Figs. 1-3), which were defined as:

- Group A—minimal evidence of oil folliculitis
- Group B—moderate evidence of oil folliculitis
- Group C—marked evidence of oil folliculitis.

The wide range and variety of different jobs suggested a possible correlation between occupation and risk of oil folliculitis. In some occupations, such as inspection, there was little exposure to oil, other than as a result of handling small oil-contaminated components. Other occupations, for example, capstan-lathe operation, drilling, and automatic-lathe operation, subjected the worker to much heavier contamination, especially with oil under pressure. It was also apparent that work at certain machines, such as capstan lathes and automatic lathes, exposed the skin to much frictional contact with oil-soaked machinery; this was an unavoidable accompaniment of frequent manual adjustment of component and cutting tool.

In the tables which follow, the occupations are referred to by a numerical code set out below.

OCCUPATIONAL CODE	
1	Inspector
2	Fitter
3	Driller
4	Grinder
5	Capstan-lathe operator
6	Centre-lathe operator
7	Miller
8	Automatic-lathe operator
9	Labourer
10	Sheet metal worker
11	Heat treatment worker
12	Oil storeman
13	Turner
14	Painter
15	Tool maker
16	Welder

Table 1 gives the distribution of oil folliculitis by occupation. Although the numbers in some occupational groups were small it was possible to determine whether, in fact, some occupations tended to carry an increased risk of the more severe degrees of oil folliculitis.

In occupations 5 and 8 there was a significantly higher proportion of men with moderate and marked oil folliculitis. Occupation 3 also contained a higher proportion of men with the more severe degrees of folliculitis, but the numbers were insufficient for statistical confirmation. In occupations 1, 2, 4, and 9-16, there was a high proportion of men with minimal evidence of oil folliculitis. This pattern of distribution suggests that in the occupations of driller, capstan-lathe operator, and automatic-lathe operator, there is an increased risk of developing oil folliculitis.

Age and Duration of Exposure to Oil.—In previously published work there has been a tendency to regard oil folliculitis as a dermatosis incidental to exposure to oil, which is more or less liable to occur in any worker handling a machine tool. On the assumption that the risk of oil folliculitis is unrelated to occupation, the more severe degrees of this occupational skin disease might be expected to occur in those workers with the longest exposure to oil, and men of older age groups might be expected to show the largest incidence of marked oil folliculitis. Table 2 shows that this is not so.

In those occupations, 3, 5, and 8, which are suspected of carrying an increased risk of oil folliculitis, the average age is less than in most of the other occupational groups. The average duration of exposure for these occupations is also shorter than the average exposure of men in the other groups.

These findings suggest that duration of exposure to oil is not of much importance in the development of oil folliculitis. Susceptibility to this occupational dermatosis does not appear to increase with age. It is possible that men of advancing years, who had experienced occupational skin diseases, might have sought other employment in work with little or no exposure to oils. This has not been the case as far

TABLE 1
DEGREE OF OIL FOLLICULITIS BY OCCUPATIONAL GROUPS

Rating of Oil Folliculitis	No. of Men in Occupations 1-16									
	1	2	3	4	5	6	7	8	9-16	Total
A Minimal	7	16	3	13	9	2	7	—	10	67
B Moderate	2	10	7	8	31	6	7	—	6	77
C Marked	6	7	7	7	15	1	6	6	1	56
	15 $\chi^2=4.1$ n=2 P=0.10	33 $\chi^2=3.34$ n=2 P=0.20	17 $\chi^2=2.35$ n=2 P=0.30	28 $\chi^2=2.23$ n=2 P=0.30	55 $\chi^2=9.3$ n=2 P=0.01	9 $\chi^2=3.23$ n=2 P=0.20	20 $\chi^2=0.1$ n=2 P=0.95	6 $\chi^2=13.2$ n=2 P=0.01	17 $\chi^2=3.56$ n=2 P=2	200

TABLE 2
AGE AND DURATION OF EXPOSURE OF MEN IN DIFFERENT OCCUPATIONS

	Occupations								
	1	2	3	4	5	6	7	8	9-16
Average age (years)	42.5	42.3	40.7	28.2	34.5	34.5	40.8	33.3	44.5
Average duration of exposure (years)	25.8	24.0	5.4	8.5	8.9	16.0	15.8	11.5	12.1

as experience in this factory is concerned. No man has left his employment, or been transferred to other work within the factory, on account of oil folliculitis since 1955.

There is no evidence to suggest that increasing duration of exposure to oil renders the skin resistant or "immune" to the development of folliculitis. Indeed it may be that one episode of folliculitis increases the susceptibility of the skin to the deleterious effects of cutting fluids. The fact remains that occupations 3, 5, and 8, with relatively short exposure to oils and using young workers, carry an increased risk of workers developing the more severe degrees of folliculitis.

Degree of Oil Exposure.—Observation in the factory suggested that an approximate estimate of oil exposure could be made and classified as light, medium, and heavy. The occupations were classified as follows:—

- (a) Light1, 9-16
- (b) Medium2, 4, 6, and 7
- (c) Heavy3, 5, and 8

Subsequent discussion with the works superintendent and several department foremen confirmed this assessment.

Table 3 gives the degree of oil exposure according to occupation, as assessed by the men themselves. In occupations 3, 5, and 8, there was a tendency on the part of the machinists to underestimate their degree of exposure, although there was a statistically significant excess of oil exposure in these occupations. This seems to be confirmatory evidence of the extra risk attached to occupations

3, 5, and 8. In occupation 1, the tendency towards overestimation may be due to the fact that the majority of men employed on inspection had previous machine tool experience, for example, as capstan-lathe operators, drillers, or grinders. This may explain the high percentage of inspectors (occupation 1) who regarded the degree of their exposure as "medium".

Type of Oil Exposure.—The marked variation in the physical characteristics of the oils used in the factory for different machining processes suggested a possible connexion between the degree of oil folliculitis and the type of oil exposure. The extreme viscosity of some insoluble cutting oils was regarded as a most undesirable feature, and one which could only damage the skin.

Table 4 gives the type of oil exposure in the high-risk occupations. The one significant feature in this table is the fact that all six men employed on the automatic lathes had marked oil folliculitis and had been exposed predominantly to an insoluble oil, A. This oil is the only one used on the automatic lathes. By contrast, several insoluble oils are in use on the capstan lathes and drills, where

TABLE 4
TYPE OF OIL EXPOSURE IN HIGH-RISK OCCUPATIONS

Type of Oil Exposure	Occupation Code No.				Total
	3	5	8	Others	
Soluble oils	—	28	—	33	61
Insoluble oils	—	5	6	4	15
Mixed oils	17	22	—	85	124
Total	17	55	6	122	200

TABLE 3
MEN'S OWN ASSESSMENT OF DEGREE OF OIL EXPOSURE IN DIFFERENT OCCUPATIONS

Degree of Oil Exposure	No. of Men in Occupations 1-16									Total
	1	2	3	4	5	6	7	8	9-16	
Light	6	16	—	14	8	3	3	—	12	62
Medium	9	14	10	13	37	6	16	2	4	111
Heavy	—	3	7	1	10	—	1	4	1	27
Total	15	33	17	28	55	9	20	6	17	200
	$\chi^2=4.51$ $n=2$ $P=0.10$	$\chi^2=4.8$ $n=2$ $P=0.10$	$\chi^2=14.94$ $n=2$ $P=0.01$	$\chi^2=5.6$ $n=2$ $P<0.10$ >0.05	$\chi^2=7.2$ $n=2$ $P<0.05$	$\chi^2=1.4$ $n=2$ $P=0.50$	$\chi^2=4.9$ $n=2$ $P=0.10$	$\chi^2=15.2$ $n=2$ $P=0.01$	$\chi^2=12.3$ $n=2$ $P=0.01$	

there is a high proportion of men exposed to both soluble and insoluble oils. The large number of men exposed to mixed-oil contamination precludes any definite conclusion being drawn from the evidence presented in this table. But it is possible that the extreme viscosity of oil A contributes in some measure to its ability to induce occupational skin disease.

Skin Cleanliness.—It is often considered that close attention to personal hygiene effects a reduction in the incidence of occupational skin disease. Bearing in mind the characteristics of some mineral oils, it was decided to try to determine the preventive role of personal hygiene. A study was made of the range of washing facilities available to the workers, both in the factory and at home. It does not follow that a man's skin is always clean because his home washing facilities are excellent, and the converse of this is also true. However, an index of home washing facilities was constructed in the following manner:—

- Class A those men who had a bathroom with bath, and running hot and cold water
- Class B those men who had only wash-basins with running hot and cold water
- Class C those men who had indoor or outdoor wash-basins, but no running hot water available

The distribution of workers according to this index is shown in Table 5.

TABLE 5
HOME WASHING FACILITIES ACCORDING TO OCCUPATIONAL GROUPS

Home Washing Facilities	No. of Men in Occupation Code Nos.				Total
	3	5	8	Others	
Class A	9	37	5	61	112
Class B	3	7	—	17	27
Class C	5	11	1	44	61
Total	17	55	6	122	200

Table 5 reveals that in the high-risk occupations (3, 5, and 8) 65% of the men had adequate access to baths and running hot water; this figure is somewhat better than that for the men in low-risk occupations with little oil folliculitis. Whether satisfactory use was made of the available washing facilities could not be determined, but the figures suggest that the provision of baths and hot water is not sufficient to prevent the development of oil folliculitis.

Previous History of a Dermatitis.—The suggestion that a previous history of skin disease, either occupational or non-occupational, renders a person liable to a subsequent occupational dermatosis, has

already been mentioned. This point is examined more closely in Table 6.

TABLE 6
PREVIOUS SKIN HISTORY OF MEN IN DIFFERENT OCCUPATIONS

Previous Skin History	No. of Men in Occupation Code Nos.				Total
	3	5	8	Others	
None	5	37	—	104	146
Previous occupational dermatosis	12	17	6	16	51
Previous non-occupational dermatosis	—	1	—	2	3
Total	17	55	6	122	200

In the high-risk occupations there was a high incidence of previous occupational dermatosis. The number of acute episodes experienced by each man varied from one to seven during the period of three years for which sickness record cards were available. These figures emphasize the chronicity of oil folliculitis in those men engaged in the high-risk occupations. The importance of a previous history of non-occupational skin disease could not be elucidated in view of the small number of men who owned to having experienced such a condition. Nevertheless, the data suggest that oil folliculitis is a recurrent disorder in those who work in the high-risk occupations. The possible consequences of this chronicity are discussed later.

Barrier Cream.—For 12 months before the start of this study, a proprietary cream had been freely available to all men working in the factory machine shop. I was always doubtful whether this preparation was much used, and also whether it was of value as a preventive measure.

TABLE 7
USE OF BARRIER CREAM BY OCCUPATIONS AT RISK

Barrier Cream	No. of Men in Occupation Code No.		Total
	3, 5, & 8	Others	
Used	33	19	52
Not used	45	103	148
Total	78	122	200

Much greater use was made of barrier cream in the high-risk occupations. It is possible that the men who worked in high-risk occupations appreciated the dangers of excessive oil contamination. This contamination was not associated with the low-risk occupations, in which fewer men were habitually using barrier cream. The men who made most use of the cream were those with the highest incidence of folliculitis, which does not suggest that

FIG. 4

the cream was of much value as a preventive measure.

It is concluded from these results that: (a) An increased risk of oil folliculitis is associated with certain occupations; (b) the degree and type of oil exposure are closely related to the severity of the oil folliculitis; (c) the importance of personal hygiene, including the use of barrier cream, has not been established.

In order to discover why personal hygiene appeared to be ineffective as a preventive measure, the following experiment was conducted. The object was to show photographically whether mineral oil, as used routinely in the machine shop, could be removed from contaminated skin. The method, first described by Cruickshank (1948), was based on the property possessed by certain mineral oils of fluorescing in the presence of ultra-violet light; the source of light was a Wood's lamp as described above. My own left arm, previously washed with soap and water was photographed (Fig. 4).

A square, 2 in. $\times$ 2 in., on the extensor surface of the arm was then painted with a wool-applicator moistened with a mineral oil. The result is shown in Fig. 5.

The arm was then washed vigorously with soap and water for 15 seconds and the effect of this method of cleaning is shown in Fig. 6. Numerous pinpoints of fluorescence were present under ultra-violet light, indicating that oil was still present on the skin, and in the follicles.

The square on the arm was then repainted with the same oil, and then washed with a patent industrial skin cleanser for 15 seconds.

Washing with soap and water failed to remove the oil effectively from the skin and appears to be inadequate to prevent oil folliculitis.

Discussion

The questions posed under "Method of Survey" above will now be considered.

(1) Is One Job More Hazardous than Another?—

The small number of employees studied in this investigation makes it impossible to be dogmatic about interpretation of the results. Nevertheless, the analysis of the collected data suggests that machine tool operators employed on drilling machines, capstan lathes, and automatic lathes are more likely to develop oil folliculitis than other workers in the machine shop.

The existence of high- and low-risk occupations among machinists does not seem to be widely recognized. A search of the literature failed to discover any investigation, other than that of Klauder (referred to earlier), which compared the

FIG. 5

FIG. 6

relative incidence of oil folliculitis in different occupational groups.

(2) Are the Type and Degree of Oil Exposure of Importance?—As far as the type of exposure is concerned, little of value emerges from the data collected. All six automatic lathe operators presented with a marked degree of oil folliculitis, and were known to have been exposed consistently to one type of oil, which may have been a significant factor in the causation of occupational dermatosis. This oil is an extremely viscous substance; the viscosity may be regarded as an index of toxicity. It is theoretically possible that adhesion of the oil to the skin allows more prolonged interaction between the skin and any irritants in the oil. It is my opinion that exposure to this type of very viscous oil, under the conditions which exist at automatic lathes, is an important contributory cause of oil folliculitis.

The degree of oil exposure has not been assessed in any previously published work on oil folliculitis. This is probably due to the difficulty of estimating the extent of oil contamination. The presence of mineral oil on clothing or skin can be detected by its fluorescence in ultra-violet light, but there is so far no suitable apparatus for quantitative estimation applicable to mixed-oil contamination. In the absence of such an instrument, it is necessary to rely on simple but crude methods of assessment.

In the factory machine shop it is obvious even to an unskilled observer that there are two extremes of oil exposure, described as light and heavy. Light exposure may be defined as the minimal contamination experienced by those employees whose work involves mainly handling oily components, or the operation of machines where the daily contact between cutting fluid and skin is brief.

Heavy exposure is that which is sustained by those who work more or less continually at machines where cutting speeds are high, oil flow is heavy, and daily contact between skin and cutting fluid is long.

To disregard this great variation in degree of oil contamination would be unwise. Basically, these cutting fluids are irritants, and it seems reasonable to assume that the greater the concentration of irritant upon the skin, the greater the risk of oil folliculitis. The evidence presented in the previous section confirms this assumption.

(3) Does Personal Hygiene Reduce the Risk of Oil Folliculitis?—Cleanliness of the machines and working environment, while desirable, is difficult to attain. The working speed of many machines is high and, as a result, cutting fluid is splashed in all directions, contaminating static parts of machinery

and attendant workers. Certain jobs involve the machinists in frequent manual adjustment of controls or workpiece, to reach which necessitates frictional contact between oil-soaked machinery and the skin. This is a difficulty which cannot be easily surmounted with the present design of machines. In an attempt to reduce oil contamination, splash-guards should be fitted to the machines wherever possible; these guards can effectively reduce the amount of oil deflected from the edge of the cutting tool, and afford some measure of protection for the workers. Regular degreasing of equipment is part of every maintenance programme, and in this operation, attention must be paid to the oil supply. The oils may require frequent changing and filtering to combat rancidity, deterioration, and excessive sediment.

To reduce oil contamination of workers is in theory a relatively simple matter. Protective garments, including aprons, armlets, leggings and visors, made of various synthetic materials have been designed. But despite adequate provision of protective clothing, there is a remarkable disinclination on the part of the average worker to avail himself of these facilities. The relative inefficiency of soap and water as cleansing agents was demonstrated in Figs. 4-6. Only a minute amount of oil, certainly less than 1 ml., was required to provide such evidence, and the effects of widespread oil contamination may be considerable. Out of 200 men interviewed and examined, fewer than 20 used a freely available patent industrial skin cleanser as part of their daily personal hygiene. As the use of this cleanser was the only efficient method of removing oil from the skin, it follows that in about 90% of the men the skin was never completely free from oil. This fact is of major importance.

A barrier cream may be defined as a cream applied to the skin before beginning work to protect the skin from the injurious effects of irritants and to facilitate cleansing. There are two main types of barrier cream available for use: (a) water soluble and (b) water insoluble. In the engineering industry it is essential that the cream should not be soluble in cutting fluids, and this is a difficulty not easily overcome.

As early as 1922 Scott suggested that the occupational dermatoses of paraffin workers might be less troublesome if some form of protective application to the skin were to be employed. In this instance, semi-crude castor oil was the choice. More recently, Klauder, Gross, and Brown (1940) conducted a survey of workers suffering from occupational dermatitis, inquiring especially about personal washing habits, the type of soap and cleanser used, the frequency of washing, and the use of emollient

or protective creams. Their subsequent recommendations were that any protective medicinal application should be sufficiently adherent so that it was not easily rubbed off, and yet was readily removable by washing at the end of the working day; objectionable features, such as excessive greasiness, stickiness, or drying, should not be present, and the ingredients should have no sensitizing capacity.

To produce a protective cream with all these desirable properties has been, for some years, the objective of many manufacturing chemists. However, a first impression that this was to be the answer to the problem of occupational skin disease was soon amended as the result of a memorandum by the Factory Department, Ministry of Labour and National Service (1946), in which it was emphasized that no completely effective barrier cream had been developed for use in the engineering industry. This was soon followed by a report from Cruickshank (1948) who investigated the efficiency of many of the barrier creams then available to industry. All the creams tested permitted penetration by oil if contamination was of one hour or longer. This study by Cruickshank clearly exposed the limitation of barrier creams, and indicated that to be of any real value in the engineering industry, frequent application was essential. A more recent development has been the introduction of silicone-containing creams which may be effectively resistant to oil penetration for much longer periods. Their widespread use in the engineering industry at present is precluded by expense.

(4) Is There Any Danger of Malignancy?—Only rarely does oil folliculitis cause absence from work; only two men in the group studied lost working hours on account of this occupational disorder during the past three years. The most important reason for prevention is therefore the possibility of malignant skin change. As early as 1922 Scott described skin cancer in paraffin workers, and his findings were fully confirmed by Leitch (1922). The carcinogenic property of mineral oils was investigated by Twort and Twort (1931), and as a result of their experiments on mice, they concluded that the heavier grade oils were less potent than spindle oils; it was also suggested by these workers that the fluorescence of oils might be related to their carcinogenic potency. More recently the work of Cruickshank and Squire (1950) on cancer of the skin from the use of mineral oils in the engineering industry has confirmed that the hazard of skin cancer in certain jobs in engineering does exist. Their evidence was drawn from: (a) Observation of workers in an automatic machine shop; (b) analysis of records of patients with scrotal

cancer reported to the Birmingham United Hospitals (1939-48); (c) production of tumours in animals by painting the skin with a sample of cutting oil from automatic machine shops.

The skin lesions encountered were classified in two groups: (1) oil folliculitis and (2) hyperkeratoses similar to those found in tar workers and mule spinners.

Warts were observed in 33% of 138 workers, and it was noted that the percentage of men affected rose steadily with increasing duration of exposure. Over 50% of those workers with more than 15 years of exposure showed evidence of these pre-malignant skin lesions.

The present study has not provided any confirmation of the occurrence of skin cancer in those workers exposed to a variety of cutting oils. None of the 200 men in the study showed any evidence of pre-cancerous or malignant skin lesions. The explanation for this may be that the majority of men in the high-risk occupations have not been exposed to oils for long enough; the factory has been engaged in production for less than 10 years.

The work of Cruickshank and Squire (1950) suggests that the prevention of oil folliculitis is of extreme importance. In this respect, the recommendations of the Annual Report of the Chief Inspector of Factories on Industrial Health (1958) may be summarized as follows:—

- (a) Replacement of irritant materials by non-irritants where possible.
- (b) Selection of workers so that those whose skins are vulnerable to potential skin irritants are excluded.
- (c) Reduction of contact between irritant and worker to a minimum.
- (d) Regular medical inspection of those exposed to contamination by irritants.
- (e) Establishment of adequate cleansing facilities. It was shown above that a suitable skin cleanser effectively removed oil from the skin.

The prevention of oil folliculitis remains essentially a problem for the engineer. Until machines are so designed that contact between cutting coolant and operator's skin cannot take place, this type of occupational skin disease will continue to occur.

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