Case Reports

Occupational Health Case Report—No. 5

Cutting Oil Mists

The Occupational Safety and Health Act of 1970 authorizes the National Institute for Occupational Safety and Health (NIOSH), on appropriate request, to investigate conditions where a potential health hazard is suspected.

JOM is reviewing, as case studies and as teaching tools, reports of such NIOSH Health Hazard Evaluations investigations. This month Case Reports No. 5 and No. 6 represent edited versions of selected reports which we believe are of interest to industrial physicians and industrial hygienists.

The comments of readers concerning the problems discussed in these reports will be welcomed and will be published as space permits.

—The Editor

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1. Introduction

The National Institute for Occupational Safety and Health (NIOSH) received a request from an authorized representative of employees, regarding dermatitis from exposure to various lubricating cutting oils and cooling oils in certain sections in a company manufacturing power wood working shop tools (table saws, radial arm saws, jointers, planers, etc.) This modern industrial facility has been in operation for the past eight and one-half years.

2. Background Hazard Information

A. Substances and Toxic Effects.

The alleged health hazard is dermatitis attributable to various lubricating, cutting and cooling oils. Cutting and coolant oils in the workplace are:

Compound 1. A chlorinated, sulfonated, lard-type, mineral oil.

Compound 2. A compound used for grinding operations.

Compound 3. A water soluble, synthetic cutting oil containing the following compounds: Sodium nitrite, amines,*† fatty acids,* morpholine,* polyglycol lubricants, glycerol coupling agents, alkanolamine surfactants,* quaternary ammonium compounds,*† triethyl-s-triazine, vegetable oil, and organic foam dispersants.† This coolant is normally diluted 1:20 before use (pH 8.5-9.0).

Compound 4. This is used in only one machine.

Compound 5. This is used only on Barber-Coleman-Hobby machines.

Compound 6. Kerosine and Microhone coolant. This is presently utilized in only one machining operation.

Compound 7. This is a non-chlorinated, non-sulfonated, insoluble, lard type oil. It is used in machining non-ferrous metals, in this instance Aluminum and Zinc alloys because of its non-staining properties.

Contact with cutting oils can result in several distinct types of dermatologic problems. These can be best classified by the mode of underlying pathophysiology: (a) mechanical blockage of the skin pores, (b) primary irritant reactions, (c) allergic sensitizations. These are all caused by direct contact between the skin and oily substances. Thus similar preventive measures are effective regardless of the responsible mechanism involved.

(a) Oil acne and folliculitis result from the simple mechanical blockage of the follicular openings by insoluble oils. Infrequent skin cleansing and the prolonged wearing of soiled clothing frequently predispose to this condition. The hairy skin surfaces are involved, most commonly, the backs of the fingers, forearms and thighs. Initial blockage of the hair follicle results in comedone formation. This is followed by papular lesions and varying degrees of inflammation. It is commonly, but mistakenly attributed to the presence of bacteria in cutting fluids. While it is true that cutting oils and coolants may contain large numbers of micro-organisms, which may cause rancidity, these organisms are nearly always non-pathogenic and incapable of causing infection. When true infections are occasionally seen as a complication of oil acne, bacterial cultures nearly always demonstrate that the invading organisms have originated on the patients own skin, or in his mouth or nose.

(b) Primary irritants are those agents which produce cutaneous inflammation by direct action at the point of contact, providing the concentration and duration of action are sufficient. These agents are usually chemical although similar reactions may be caused by radiation or thermal injury. Most occupational contact dermatitis (80%) is of this type.

Primary irritants are generally divided into the absolute irritants and the relative irritants. Absolute irritants are intrinsically damaging corrosive substances which have their effects immediately following first contact. The best examples are strong acids and alkalies. These substances cause identical responses in all persons and the primary factors are concentration and duration of contact. The relative primary irritants are less intrinsically toxic and usually require repeated and prolonged contact to evoke inflammation. A great many chemicals, solvents, soaps, and detergents are relative irritants.

* Known primary cutaneous irritants
† Known cutaneous sensitizers

Personal susceptibility is extremely important in determining who is effected by such agents. Dryness of the skin, the presence of other skin diseases, and the amount of skin pigment are all important factors. Friction, pressure, sweating, maceration and occlusion also are predisposing factors.

Since these factors are almost never absolutely equal among exposed persons the extent, severity and duration of irritant dermatitis varies widely. Many individuals after daily exposure to irritants develop a tolerance which permits further exposure without further evidence of irritation. Unfortunately, other persons tend to remain in a "hypersusceptible" state following partial or apparently full recovery from irritation. Such individuals suffer frequent exacerbations and have a tendency toward long periods of chronic dermatitis which respond poorly to treatment. The characteristics of the agent are also important and irritation increases if there is chemical instability, water solubility or a tendency toward ionization. While any area of the body may be involved; the hands are the usual site of involvement, especially in chronic cases. In machinists the cause is usually the soluble synthetic cutting oils or coolants.

(c) A final category of cases results from true allergy. This is usually due to specific substances, usually additives, and not the cutting oil itself. The most common sensitizing substances found in oils, include bichromate, formaldehyde, cresol, nitrobenzene, and phenylmercuric salts. Clinically these cases tend to be more severe, sudden in onset, and involve not only the areas in contact with the agent, but also areas with minimum exposure. Usually the person cannot tolerate any further exposure without a complete recurrence of symptoms. Thus duration and concentration are not important factors in eliciting this type of dermatitis.

B. Other Agents.

1. 1,1,1 Trichlorethane (Methyl Chloroform). This commonly used industrial solvent is employed in degreasing metal parts and in clean-up operations. The effects of methyl chloroform are due to its depressive action on the central nervous system. Incoordination and a sensation of drunkeness preceed actual anesthesia. It apparently has little capacity to produce organic injury either from single or repeated exposures. In common with many solvents it may defat the skin and render it more susceptible to injury. The small quantities utilized and the total lack of symptoms attributable to this agent allow it to be dismissed from further consideration.

2. Soaps. Abrasive and alkaline hand soaps commonly contribute to irritation and the continuation of hand eczemas. In this facility a soap powder is provided which is moderately alkaline; its frequent use may contribute in a minor way to the dermatitis.

3. Health Hazard Evaluation

A. Observational Survey

The facility was visited on January 30-February 1, 1973. This plant employs a total of approximately 785 persons, of those 650 are directly involved in production operations. The plant operates three shifts, 40 hours per shift. The sections involved employ approximately 50 persons during all three shifts. The day shift is the largest shift and it employs approximately 30 persons.

B. Environmental Evaluation

Section A carries out various machining operations on steel bar stock. These include grinding, drilling, various lathe and automatic screw machine operations. Section B which is immediately adjacent, carries out milling, boring, gun drilling, honing, and grinding procedures on aluminum and zinc alloy castings. Castings are purchased and no foundry operations are carried out. Nickel or chromium containing metals are not used. Large amounts of various lubricating, cooling, and cutting fluids are used in both Sections. Individual operations are discontinuous, i.e., a certain number of specific parts are machined and then this part is not made again until the supply is depleted. This means that employees shift about and are capable of becoming involved in a variety of machining operations as needed.

In many of the machining operations, large volumes of oils are lost daily due to finished part carry off and splashing. For most machines approximately two-thirds of the total volume is replaced daily.

Rubber gloves, aprons, and barrier creams are available without cost. Safety glasses are provided for workers involved in machining operations and their use is mandatory.

Compounds 3 and 7 appeared to create dermatitis problems. Bulk samples of each were obtained in both concentrated and used forms and in addition to soaps were submitted to the Division of Laboratories and Criteria Development, NIOSH, Cincinnati, Ohio. Since dermatitis is a skin condition associated with direct chemical contact, air samples were not deemed appropriate or necessary.

The oil and soap samples were analyzed for pH and milliquivalents of acid needed to bring the solution to neutrality. The oil was diluted 20 to 1 prior to analytical evaluation. Analytical results on bulk samples are found in the Table.

In machine shops where cutting oils are used, dermatitis is a common condition. The best control for dermatitis is to avoid direct exposure or use of protective gloves or hand cream. Thus, good hygiene practice must be diligently exercised. It is recognized that direct contact can not always be avoided or that some protective measures are not feasible.

C. Medical Evaluation

1. Medical Investigation and Results:

All 41 individuals who work in Section A and B on both first and second shifts were interviewed and given cutaneous

Summary of Bulk Samples

Sample	pH	Acid Milliequivalent*
Soap powder	9.4	20.4
Compound 3 (cutting oil) (Used)	8.7	1.1
Compound 3 (cutting oil) (Diluted)	8.6	3.2
Compound 7 (cutting oil) (New)	7.0	0.0
Compound 7 (cutting oil) (Used)	7.0	0.0

* Milliequivalents: Amount of acid required to reduce the pH to neutrality, i.e., pH 7

examinations when indicated. The skin seemed to be the only organ involved.

Eleven cases of active dermatitis were identified. Three were extremely mild and subsiding which prevented exact classification. Five were clinically classic cases of oil folliculitis (oil boils, oil acne) and involved the forearms and the anterior portions of the thighs. No cases of secondary infection were noted. These workers were all operating machines in which compound 7, an insoluble, heavy weight oil was used. None of the affected were noted to be wearing protective gloves, long sleeves, or aprons. Several persons stated that aprons were too hot in the summer or that they caused oil to drip down upon their shoes. Some stated that gloves might actually be a safety hazard although it was noted that other workers apparently performing identical operations were wearing gloves.

Three cases of primary irritant hand dermatitis were identified. All denied a history of atopy or other known predisposing causes. These cases were all associated with the use of compound 3. Possible minor aggravating factors in these cases include both the use of methyl chloroform in clean-up and the available hand soap. Similar work practices, as previously described for the oil folliculitis cases, were also observed among these workers. Nearly all affected individuals denied using protective barrier creams although these are available.

While only 11 cases of active dermatitis were noted during the survey, it should be pointed out that ten other individuals gave a history of similar problems since employment.

2. Summary of Investigation:

As a result of this investigation, 11 cases of dermatitis were found in 41 individuals examined. A history of similar problems was obtained from ten other employees. In view of the relatively large number of new employees, who are largely unaffected to date, this represents a comparatively high incidence of dermatitis among longer term employees.

Both oil folliculitis (oil boils) and primary irritant dermatitis were encountered and shown to be related respectively to the use of compounds 3 and 7. No other medical conditions of occupational origin were found during the course of this survey.

D. Conclusions

Based on the data presented above it has been determined that compound 3 and compound 7 cutting and coolant oils encountered in various machining and milling operations in Sections A and B have produced toxic effects in the concentrations as found or used. Substantial numbers of dermatitis cases were encountered which contribute significantly to the morbidity and time loss experienced by exposed employees.

The control of dermatitis due to machining oils require dedicated effort on the part of both employees and management. It is a problem invariably associated to a large degree with poor work practices and inadequate hygiene. Sporadic cases become almost inevitable if breaks in technique and sufficient skin contact occur.

4. Recommendations

A few suggestions designed to minimize this problem follow:

1. If at all feasible cutting or coolant oils causing dermatitis should be substituted with a less toxic material.

2. As much protective clothing as is consistant with job safety should be worn. This includes rubber gloves, tight fitting sleeve gauntlets, and rubber or plastic aprons. Clothing should not be allowed to become saturated with oil and should be laundered after each day's wear.

3. External surfaces of splash guards, shields or other machine parts which frequently come into contact with the clothing or skin should be frequently cleaned and wiped free of oil.

4. When gloves cannot be worn some protection is conveyed by the *frequent* application of protective barrier creams. Haphazard use of these preparations probably accomplishes little more than establishing a false sense of security.

5. The last line of defense consists of the proper removal of oils reaching the skin. Personal cleanliness is a must. Waterless hand cleaners are especially valuable in removing oil from the skin. Raw solvents should never be used. Persons with a history of hand dermatitis or those developing it from contact with waterbase lubricating coolants should use only a mild white soap, in cleansing.

6. Should irritant dermatitis occur despite the foregoing, *prompt* and expert medical advice should be sought. This permits rapid and complete healing and reduces or eliminates time loss. Even expert medical management may be of little avail once a chronic state is reached.

7. Prospective employees with a significant history of dermatitis or pre-existing skin disorders should be excluded from employment where exposure to cutting oil, lubricants, or coolants is likely to occur.