**Metalworking Fluid Hand Dermatitis**

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Abstract: In a household appliance plant, several rinse-free lubricating fluids have been used instead of neat mineral oils since 1994: mixtures of isoparaffinic hydrocarbons with 9 to 14 carbons per molecule. As such they denature keratin, irritate and defat the skin, and remove water from it. Work gloves have been worn over plastic gloves and separate, reusable, cotton inner gloves have been added to absorb sweat since skin problems were first recognized in 1994. All 74 males (mean ± SD, 38.8 ± 8.0 years) who work with the fluids were interviewed and given cutaneous examinations when indicated. While 4 cases of severe dermatitis and 31 cases of mild dermatitis were identified, 28 individuals gave a history of similar problems since the use of lubricating fluids. Their symptoms were typical of primary skin irritation. The hands were the commonly affected region (63 of 63 cases: 100%), followed by the thighs (15.9%) and trunk (11.1%). The work-related skin symptoms identified were less common in workers who immediately removed the liquid with soap and water, when it is spilled on the hands, than in those who did not, but the difference was not statistically significant (7/23 (30.4%) vs. 28/51 (54.9%), p=0.051 by chi-square test). Since skin contact with metalworking fluids (MWF) is often unavoidable, good personal hygiene is important in minimizing potential adverse health effects. Health education thus remains the most important preventive measure against irritant contact dermatitis among workers handling MWFs.

Key words: Occupational, Irritant contact dermatitis, Metalworking fluids, Field study

Metalworking fluids (MWF) are liquids that flow or are sprayed over metal that is being altered physically or mechanically through cutting, grinding, drawing, tapping, or rolling. MWFs have two primary functions: (1) to cool, which prevents distortion of the workpiece and prolongs tool life, and (2) to lubricate, which minimizes frictional heat formation. Secondary functions are to prevent rust and to flush away metal chips. Therefore, these fluids are vital to the success of the machining operation and are widely used in industry. On the other hand, MWFs are the most important cause of hand dermatitis in the metal industry¹⁻³. To our knowledge, this is the first report on hand dermatitis caused by direct skin contact with the liquid in a Japanese occupational population.

In May 2001 we received a request from a health service station, regarding dermatitis from exposure to several MWFs in certain sections in a company manufacturing an outdoor unit for an air conditioner. This plant has been in operation for the past thirty-three years. At the beginning of production, straight oils were used as lubricants and 1,1,1-trichloroethane was used in metal degreasing. However, under the international agreements for the protection of the ozone layer, the use of chlorofluorocarbons and chlorinated hydrocarbons such as 1,1,1-trichloroethane was prohibited in Matsushita Electric Industrial Co. by 1995. Therefore, since 1994 MWFs used in the workplace have been:

**Lubricant 1** (initial b.p. 170°C, end b.p. 275°C). A mixture of isoparaffinic hydrocarbons with 9 to 12 carbons per molecule, >80%. C₁₆ α olefin, <20%.

**Lubricant 2** (initial b.p. 207°C, end b.p. 250°C). A mixture of isoparaffinic hydrocarbons with 10 to 14 carbons per molecule, >99.8%. This contains very small amounts of agents for corrosion inhibition, oxidation prevention, and lubricity aids.
Lubricant 3 (initial b.p. 178°C, end b.p. 181°C). A mixture of isoparaffinic hydrocarbons with 12 carbons per molecule, 100%.

The MSDS does not declare each lubricant as a primary irritant and lacks information about cumulative irritation testing as well as sensitization testing. It is reported that oils boiling between 175–315°C are clearly primary irritants, but distillate oils with boiling ranges above 315°C generally are not\(^2\). Therefore, these lubricants cause dermatitis by direct action on normal skin and react rapidly or slowly, depending upon the amount and the length of time of the contact.

In response, we performed our investigation around the middle of June. This plant employs a total of approximately 293 persons, of those 175 are directly involved in production operations. The sections involved employ 74 persons. Sections A, B and C carry out an automatic press operation on pre-coated sheet aluminum (>99.0%). Section D carries out an automatic bending machine operation on copper pipe stock. Then cooling parts are assembled by workers, and subsequently pass through a drying oven at a temperature of 180°C which vaporizes oil adhered to the parts. Nickel or chromium containing metals are not used. The amounts of lubricants 1, 2 and 3 used in a month were about 1,750 l, about 1,620 l and about 2,580 l, respectively. Only work gloves were worn until skin problems were first recognized in 1994. The fluids can penetrate the gloves. Therefore, since then work gloves have been worn over plastic gloves and separate, reusable, cotton inner gloves have been added to absorb sweat. However, machinists cannot wear protective gloves while making an adjustment, since their tasks require fine manual dexterity.

All 74 males (mean ± SD, 38.8 ± 8.0 years) who work in sections A, B, C and D were interviewed and given cutaneous examinations when indicated. Their mean employment time was 17.7 (range 0.2–32.0) years. While 4 cases of severe dermatitis and 31 cases of mild dermatitis were identified, 28 individuals gave a history of similar problems since the use of lubricating fluids. Of the 63 cases, 22 (34.9%) were due to lubricant 1, 9 (14.3%) due to lubricant 2, and 32 (50.8%) due to lubricant 3. The workers with severe symptoms are new workers on the job (employment time 2 months) and underwent dermal treatment (Figs. 1 and 2). This may partially be due to the fact that skilled workers are immune to MWFs and/or are more careful with their skin hygiene and handling of MWFs. Thus, most workers were able to continue work.

Table 1 shows the affected sites and work-related symptoms in 63 individuals with recurrent episodes of metalworking fluid dermatitis. The hands were the

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### Table 1. Affected sites and work-related skin symptoms in 63 individuals with recurrent episodes of metalworking fluid dermatitis

<table>
<thead>
<tr>
<th>Sites and symptoms</th>
<th>Number (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands</td>
<td>63 (100%)</td>
</tr>
<tr>
<td>Redness</td>
<td>45 (71.4%)</td>
</tr>
<tr>
<td>Swelling</td>
<td>23 (36.5%)</td>
</tr>
<tr>
<td>Eruption</td>
<td>27 (42.9%)</td>
</tr>
<tr>
<td>Water blisters</td>
<td>14 (22.2%)</td>
</tr>
<tr>
<td>Dryness</td>
<td>10 (15.9%)</td>
</tr>
<tr>
<td>Scaling</td>
<td>48 (76.2%)</td>
</tr>
<tr>
<td>Thickening</td>
<td>8 (12.7%)</td>
</tr>
<tr>
<td>Cracking</td>
<td>5 (7.9%)</td>
</tr>
<tr>
<td>Thighs</td>
<td>10 (15.9%)</td>
</tr>
<tr>
<td>Trunk</td>
<td>7 (11.1%)</td>
</tr>
</tbody>
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Fig. 1. Clinical appearance of case 1 at 4 days after the occurrence of work-related skin symptoms.

Fig. 2. Clinical appearance of case 2 at 3 weeks after the occurrence of work-related skin symptoms.
commonly affected region (63 of 63 cases: 100%), followed by the thighs (15.9%) and trunk (11.1%). Dermatitis on the thighs and trunk is attributable to prolonged wearing of soiled clothing. Thus, it should be laundered after each day’s wear. Their symptoms were typical of primary skin irritation, which are characterized in the acute stage by redness, swelling, and water blisters, and in the subacute and chronic stages by varying degrees of redness, scaling, cracking, and thickening of the skin, depending upon the amount and the length of time of the contact, and repeated exposures.

On the other hand, none of the other 11 workers have yet developed symptoms of irritant contact dermatitis, suggesting that personal susceptibility is extremely important in determining who is affected by MWFs. Hence, further studies are required to clarify predisposing factors, for example, sweating, occlusion, dryness of the skin, the amount of skin pigment, and the presence of other skin diseases.

In metal workers, contact dermatitis is a very common disease that is mainly attributed to MWFs. The substitution of less aggressive MWFs for the noxious products is therefore an important measure to reduce the incidence of hand eczema. According to the manufacturers, primary irritation index of lubricants 1 and 2 was 2.1 and 1.1, respectively, on the basis of the OECD protocol, suggesting that they are oils that irritate the skin. However, cumulative irritation testing as well as sensitization testing is not done at all. This means that the practice of predictive testing for irritancy and sensitization of MWFs is unsatisfactory and does not allow the user to compare products based on their skin risk. Thus, the users should strive for standardization of MWF testing including sensitization tests and irritation tests (single application and repeated patch procedures).

Our findings that 35 cases (47%) of irritant dermatitis were identified during the survey were in good agreement with that reported by Goh et al. The authors investigated the incidence of occupational dermatitis from cutting fluids in 24 new machinists over a 6-month period. The cumulative incidence of occupational dermatitis increased from 38% at week 3 to 77% at week 6. It then decreased to 50% at week 9 and thereafter remained constant at about 50% throughout the remaining study period, suggesting that most machinists appeared to develop tolerance after 6 weeks of exposure to cutting fluid. These observations appeared to indicate that the protective gloves perfectly did not help to prevent skin irritation by MWFs. It is also reported that barrier creams did not confer protection against the irritant effect of MWFs. However, the work-related skin symptoms were less common in workers who immediately removed the liquid with soap and water, when it is spilled on the hands, than in those who did not, but the difference was not statistically significant (7/23 (30.4%) vs. 28/51 (54.9%), p=0.051 by chi-square test). Hence, the last line of defense is to effectively remove MWFs from the skin. Since personal cleanliness is always feasible, health education remains the most important preventive measure against irritant contact dermatitis among workers handling MWFs.

References