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Short Communication

An observational study on the effects of aviation turbine fuel and lubricants on the skin of Indian Air Force ground crew in flying stations

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ABSTRACT

Background: Ground crew of the Air Force routinely handle aviation turbine fuel (ATF) and lubricants and a need was felt to study the adverse effects of these substances on their skin so that remedial measures could be taken to prevent these adverse effects.

Methods: A multi-centric, cross-sectional, observational study was performed at three Air Force flying stations. 109 ground crew members of the Indian Air Force (IAF) who were in direct contact with ATF and lubricants were screened for dermatological manifestations on exposed areas. History of atopy was elicited, systemic and dermatological examination done and occlusive patch testing carried out where indicated. Fungal infections were excluded by a potassium hydroxide mount.

Results: 20 out of the 109 personnel (18.34%) were symptomatic in the form of mild irritant contact dermatitis. There was no case of allergic contact dermatitis. Only two cases showed an irritant reaction on patch testing. 65% of the symptomatic personnel were atopic. There was no predisposing trade or age group for adverse effects to ATF.

Conclusion: This study revealed that contact with ATF is associated with only mild irritant contact dermatitis in exposed ground crew members of the IAF and atopy was a predisposing factor for susceptibility to the dermatitis.

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Introduction

Ground crew in flying stations of the Indian Air Force (IAF) routinely handle aviation turbine fuel (ATF) and lubricants while carrying out their duties. Hence, it was felt that there was a need to study the effects of ATF and lubricants on the skin of the ground crew members of the IAF in flying stations and see if there were any adverse effects.

ATF is a colourless, kerosene-based jet fuel obtained at a distillation temperature between 366 °F and 626 °F. It is a clear to bright or light amber coloured liquid with kerosene-like odor.¹ Lubricants, some derived from petroleum, are also routinely used in aircraft maintenance. Though a study on dermatitis and aircrew has been carried out, very few specific clinical studies on the adverse effects of ATF and lubricants on human skin have been carried out anywhere in the world.^{2,3} No such published study in the IAF could be found to the best of our knowledge. Hence, a cross-sectional study of IAF ground crew in different flying stations was carried out to ascertain the incidence of adverse effects of ATF on skin.

Material and methods

A multi-centric, cross-sectional, clinical study of IAF ground crew handling ATF and lubricants at three Air Force flying stations was carried out between June 2013 and December 2013. All ground crew members who were direct handlers of ATF on parade in the various stations were screened for cutaneous adverse effects to ATF and lubricants by detailed history, especially history of atopy, and meticulous dermatological examination. Occlusive patch tests were carried out where indicated with 1% of ATF K-50 and three grades of lubricants (OX-27, SM-45 and OM-15) in petrolatum base. Readings were taken after 48 h, 72 h and 1 week, as per International Contact Dermatitis Research Group (ICDRG) criteria. A potassium hydroxide (KOH) mount was done for patients with skin lesions to rule out dermatophytosis.

Statistical analysis of the results was carried out with MedCalc software version 12.5.0.0. Tests of significance like P value, coefficients of correlation, comparison of proportions, etc. were carried out.

Inclusion criteria

1. Serving IAF personnel working as ground crew in flying stations.
2. Persons in contact with ATF and/or lubricants (direct handler).
3. Not on treatment with any topical medication for any skin condition.

Exclusion criteria

1. Personnel on oral steroids/immunosuppressants for any condition.
2. Proven cases of allergic contact dermatitis (ACD) to other substances.

3. Personnel with any pre-existing skin disease on the hands and forearms.

Results

A total of 109 male IAF ground crew members of various trades were screened with a mean age of 34.57 years (range 21–53 years, median 32). The male to female ratio was 1:0 as there were no females screened in the study. The mean years of service was 16.56 years (range 3–35 years, median 14 years).

A total of 20 out of 109 personnel screened were symptomatic (18.34%) and either had symptoms in the form of itching, transient whitening of skin on exposure to ATF or had objective signs in the form of visible skin rash or scaling. Some personnel had more than one symptom or sign. Only 5 personnel had clinically evident skin lesions. The skin lesions were suggestive of irritant reaction (IR) or mild irritant contact dermatitis (Figs. 1 and 2).

The trade-wise break-up of symptomatic and asymptomatic personnel is given in Table 1. The presence or absence of history of atopy, which is an important predisposing factor for irritant contact dermatitis, was ascertained in the whole population and the difference in the incidence of atopy is given in Table 2.

All cases had only intermittent short periods of contact with ATF and lubricants and no person had prolonged exposure to ATF.

Patch testing was done in only 5 individuals who had clinically evident skin lesions in the form of visible rash or scaling, which required exclusion of irritant or ACD. The occlusive patch tests were carried out with ATF and lubricant samples provided and readings were taken as per the ICDRG criteria. Only 2 persons showed an IR on patch testing to ATF alone. There was no positive case indicating ACD.

Discussion

Jet fuel JP-8 is used by the United States Air Force while ATF K-50 is used by the IAF. Occupational exposure to these substances may occur by the raw fuel, aerosol phase or fuel combustion exhaust by inhalation, oral ingestion or dermal contact.¹ Although these kerosene-based fuels have been in use for more than five decades, there is remarkably little research data published. ATF and associated lubricants, especially kerosene-based jet fuel, are known to disrupt the barrier function of the skin, increase trans-epidermal water loss (TEWL) and thus have irritant effects on the skin, especially after prolonged contact.^{1,4,5} However, they are not skin sensitizers. Dermal application of jet fuel induces immune suppression and classic delayed-type hypersensitivity (DTH), as well as induction of contact hypersensitivity to allergens applied on the skin is suppressed.⁶ Cellular immune responses appear to be more susceptible to the immunosuppressive effects of jet fuel and antibody production is unaffected.⁷ ATF, which is a petroleum middle distillate, is a known tumour promoter in mouse skin. However, when studied on mouse skin, it was found that tumour promotion

Fig. 1 – Mild ICD to ATF manifesting as hyperpigmented scaly lesions over knuckles and ulnar margins of the hands.

Fig. 2 – Mild ICD to ATF manifesting as hyperpigmented scaly macules best seen over radial side of index finger.

was linked to chronic irritation at the application site and not to the dose of the tested petroleum distillate.⁵ Long-term studies will be required to elucidate the complex interaction between these aromatic hydrocarbons and the human body.

In our study, 20 personnel out of 109 (18.35%) showed signs and symptoms of irritant contact dermatitis to ATF in the form of transient whitening, scaling of skin, mild itching or burning, which was significant [$P < 0.0001$ at 95% CI]. Out of these, only 2 personnel (1.83%) showed positive IR to ATF K-50 on patch testing, which was also significant [$P < 0.0001$ at 95% CI]. None of the personnel in our study showed ACD to ATF/lubricants, which was supported by clinical absence of eczematous lesions and a negative allergic response on patch testing with ATF/lubricants. An extensive literature search did not reveal any clinical study on the effects of ATF on skin.

The mean age of the study population was 34.57 years and ranged from 21 to 53 years. However, there was no correlation between any age group and the incidence of adverse reactions to ATF.

Table 1 – Trade-wise break-up of symptomatic and asymptomatic personnel.

Sl no.	Trade	No. of symptomatic personnel	No. of asymptomatic personnel	Percentage of symptomatic personnel	P value of comparison of proportions between trade with highest incidence [†] and others
1	Weapon fitter	2	1	66% ^a	–
2	Propulsion fitter	3	6	33%	0.7426
3	Lascar	1	2	33%	0.9935
4	Engine fitter	5	14	26.35%	0.4816
5	Structure fitter	3	13	18.75%	0.3210
6	Airframe fitter	5	25	16.66%	0.2098
7	Electrical fitter	1	7	12.5%	0.3094
8	Radio fitter	0	11	0%	0.0485
9	Plant maintenance fitter (E)	0	4	0%	0.2843
10	Logistics assistant	0	3	0%	0.3948
11	SEW	0	3	0%	0.3948
	Total	20	89	18.35%	0.1891

Table 2 – History of atopy in symptomatic and asymptomatic personnel.

	History of atopy		Total no. of personnel	Percentage of personnel with history of atopy	P value of comparison of proportions
	Present	Absent			
Symptomatic personnel	9	80	89	65%	<0.0001
Asymptomatic personnel	13	7	20	10.11%	
Total	22	87	109		

A break-up of the various trades showing the incidence of symptomatic and asymptomatic personnel is shown in Table 1. Though the percentage of personnel in weapon fitter trade having adverse effects to ATF/lubricants appears to be higher (66.66%), it is not statistically significant when compared to trades with the least incidence (electrical fitter – 12.5%) [$P = 0.3094$] or no incidence of adverse effects like radio fitter [$P = 0.0485$], plant maintenance fitter (E) [$P = 0.2843$], logistics assistant [$P = 0.3948$] and SEW [$P = 0.3948$].

However the presence of personal history of atopy was a major factor in predisposing the personnel to irritant effects of ATF/lubricants. 13 out of the 20 symptomatic personnel (65%) were atopic whereas only 9 out of 89 asymptomatic personnel (10.11%) were atopic. This striking difference was statistically significant [$P < 0.0001$]. “Atopy” is defined as a condition where a person is hypersensitive to allergic stimuli and typically presents with one or more of the following: eczema, allergic rhinitis, allergic conjunctivitis or bronchial asthma. Atopic individuals are known to have impaired barrier function of skin with increased TEWL and this predisposes them to irritant contact dermatitis.⁸ However, atopic individuals overall tend to have a decreased tendency to develop ACD because of a down-regulation of Th1 cells.⁹

ATF and associated lubricants are potential irritants and have been shown to have irritant properties on the skin in various studies.^{1,4,5} However, prolonged continuous contact with ATF or lubricants is usually necessary to produce overt irritant contact dermatitis. Aromatic hydrocarbons include ATF and associated lubricants, especially kerosene-based jet fuel inhibit DTH in the skin, which is a prerequisite for developing ACD.¹⁰

20 out of the 109 personnel in our study revealed mild degrees of irritant contact dermatitis and a significant proportion of them were atopic. Atopy is thus an important factor predisposing personnel to irritant contact dermatitis on exposure to ATF or lubricants.

Neither any specific trade nor any age group was specially predisposed to developing irritant contact dermatitis to ATF or lubricants. Since all personnel in this study had only intermittent exposure to ATF/lubricants during all their years of service and the total number of years of exposure could not be calculated, it is not possible to correlate the duration of exposure with the incidence of adverse effects.

None of the personnel in our study had ACD to ATF or lubricants, which was confirmed by a negative allergic patch test to samples of ATF and lubricants provided.

The irritant effects of ATF and lubricants on the skin of ground crew members can be avoided by wearing protective

lined or unlined polyvinyl chloride or rubber industrial gloves as specified by the bureau of Indian standards in their guide for selection of industrial safety equipment for protection of arms and hands, IS:8807-1978¹¹ while handling ATF, application of barrier creams prior to contact, immediately removing/ changing clothes contaminated with ATF, reducing the period of contact and prompt reporting of any suspected adverse effects to the medical authorities.

The limitations of this observational study are the small number of personnel screened with only one point of assessment and limited patch testing done. It is recommended that future studies be carried out on larger study groups to ascertain the relation between total duration of cumulative exposure to ATF and the incidence of adverse cutaneous effects. This will require meticulous logging of each episode of exposure and follow-up over a period of time. Patch testing of all symptomatic personnel should be done to get more accurate results.

Conflicts of interest

The authors have none to declare.

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