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**ABSTRACT**

The aerospace environment is a dynamic interaction between man, machine and the environment. Skin diseases are not particularly significant aeromedically, yet they could permanently affect an aviator's status for continued flying duty. A number of dermatological conditions lend themselves to flying restrictions for the aviator. Aircrew and ground crew are exposed to a myriad of elements that could also adversely impact their flying status. Inflight stresses during flights as well as space travel could impact certain behaviors from a dermatological standpoint. With the advent of space tourism, dermatological issues would form an integral part of medical clearances. With limited literature available on this subject, the review article aims to sensitize the readers to the diverse interactions of dermatology with the aerospace environment.

**Key words:** Aeromedical, aviation, occupational dermatoses, skin, space

**INTRODUCTION**

Aviation and space or aerospace environment is a dynamic interaction between man, machine and environment. Since skin is the first organ that interacts with this environment, it is essential to learn the dermatological implications of such an environment. With limited literature available on this subject, the review article aims to sensitize the readers to the diverse interactions of dermatology with the aerospace environment.

Skin diseases are not particularly significant aeromedically. Most dermatological diseases are transient, cause no incapacitation, and can usually be managed by a short course of topical medications. Yet it exacts a huge morbidity. During World War II, in some tropical areas, dermatological diseases comprised up to 75% of all outpatient department

(OPD) visits.<sup>[1]</sup> Skin disease resulted in almost 25% of all lost man-days aboard a US Navy aircraft carrier.<sup>[2]</sup> Another study conducted on the US Air Force aeromedical consultations found that dermatological disorders comprised 11.3% of all medical referrals. Fungal infections were the commonest disorder in 14.5%; and 50.3% involved skin disease which could permanently affect an aviator's status for continued flying duty.<sup>[3]</sup>

**SKIN AND AVIATION**

The milieu during flights is much different from those faced on terra firma which the body is accustomed and acclimatized to. These differences may contribute to inflight stresses and include low barometric pressure (565 mm Hg vs. 760 mm Hg), low PaO<sub>2</sub> (55 mm Hg vs. 98 mm Hg), low humidity (10-20%) and prolonged cramped sitting. These factors may impact certain behaviors from a dermatological viewpoint. Low humidity may hamper those suffering from atopic dermatitis, jet lag may alter timings of medications and special meals need to be catered for, e.g. gluten-free diet for those with dermatitis herpetiformis. Air casualty evacuation of dermatological emergencies, e.g. acute skin failure involves overcoming challenging issues of immobilization, maintenance of ambient

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temperature/humidity, provision of air/water mattress, oxygen supply, etc.

## OCCUPATIONAL DERMATOSES

Dielectric fluids, sealants, kerosene, jet fuel components are some of the innumerable chemicals used in the airline industry which act as skin irritants or allergens. The most important skin irritant in jet fuel components is reported to be N-phenyl-1-naphthylamine.<sup>[4]</sup> Other irritants encountered by aircrew during routine inspections of aircrafts include deicing agents, hydraulic fluid or jet fuel. Chronic exposure to visible light through cockpit windows has been blamed for the development of chronic actinic dermatitis in a pilot with known atopic eczema.<sup>[5]</sup> Contact dermatitis to flight gloves and to face mask have also been reported in the literature.<sup>[6]</sup> A helicopter pilot has been reported to have developed erythema multiforme and cutaneous leishmaniasis during 'Operation Desert Storm', a prime example of 'geographical variation'.<sup>[7]</sup>

Exposure to cosmic rays is an area of special concern. At sea level, the exposure to cosmic radiation is 0.06  $\mu\text{Sv/h}$ . At 35,000 ft level, the altitude of a commercial airliner, this exposure rises by 100 times to 6  $\mu\text{Sv/h}$ . Melanoma and non-melanoma skin cancers and prostate cancer is reportedly three times more likely to occur in pilots than in the general population; and is reportedly more likely in pilots with longer careers.<sup>[8-10]</sup> Another study has attributed enhanced ultraviolet radiation rather than cosmic radiation to the increased cancer risk.<sup>[11]</sup> A meta-analysis of studies of aircrews between 1986 and 1988 concluded that aircrews seemed to be at higher risk for melanoma, and cancer of brain, prostate and breast.<sup>[12]</sup> However, the association may be confounded by differences in lifestyle factors (circadian rhythm disruption, leisure-time sun-exposure), reproductive factors or family history.<sup>[13]</sup>

Ground crew is exposed to aviation fuels and lubricants. They are also exposed for prolonged duration to the environment during the course of their outdoor duties on the tarmac. Polymorphic light eruptions have been reported in 7% of ground crew, with a higher incidence in winters than in summers, possibly due to inadequate adaptive hardening of the skin. Prolonged wearing of flying clothing in hot and humid weather leads to sweating, which in turn

enhances the proneness to dermatophyte infection. Quality of clothing used and duration of use are other factors that may influence the pattern of skin diseases.<sup>[14]</sup>

## DERMATOLOGICAL IMPLICATIONS IN AVIATORS

A number of dermatological conditions impact the employability of aircrew.<sup>[15,16]</sup> These are conditions which tend to recur frequently; require periodic courses of systemic medications such as steroids; those that interfere with wearing of cockpit equipment; or medications that may interfere with performance. Some illustrative dermatological conditions and their influence in a flying environment are elucidated below:

*Atopic dermatitis:* Itching can be distracting; low humidity can exacerbate dermatitis; and severe exacerbations can require use of systemic steroids and antihistamines. In certain environments, systemic steroids exceeding prednisone 20 mg and sedating antihistamines are contraindications for flying duties.

*Psoriasis:* Psoriatic lesions may interfere with wearing of aviation equipment. Face and scalp psoriasis may impede wearing mask and helmet respectively; and palmoplantar psoriasis may interfere with handling cockpit controls. Psoriasis also distracts by pruritus or pain and exacerbates through repeated trauma (Koebner's phenomenon) and physically/emotionally strenuous work. Medications like Psoralen + UltraViolet A (PUVA) and methotrexate are incompatible with flying duties; and psychological aspects may also affect the aviator's duties.

*Acne:* Conditions like cystic acne interfere with wearing of aviation equipment; exacerbates due to rubbing, pressure, or exposure to hot/humid environments; and has associated psychological issues. Use of medications, e.g. isotretinoin may impair flying duties on account of photosensitivity and impaired night vision.

*Urticaria:* Flight restrictions depend on the frequency of episodes, extent and severity of lesions, and type/amount of medication necessary to achieve symptomatic control.

*Contact dermatitis:* Distraction by pruritus/pain, systemic complications, associations with other disease processes, interference with wearing of

protective aviation equipment, medications that are incompatible with flying duties and recurrence of symptoms on re-exposure are issues to consider for aviation duties.

*HIV infection:* A significant percentage develops subtle neurobehavioral and cognitive deficits; and nearly 50% show additional deficits under conditions of hypoxia. Risk of depression/suicide, seizures or sudden violent or disturbed behavior may also influence flight restrictions.

*Others:* Those with palmoplantar hyperhidrosis, leprosy with nerve function impairment, *Herpes zoster*, etc. need suitable flight restrictions.

*Drugs:* Only those medications which do not interfere with the performance of flying duties or use of personnel/life-support equipment such as topical antiseptics/antifungals/hydrocortisone/benzoyl peroxide/tretinoin/acyclovir, etc. are permitted during flying duties.

Individual employability restrictions or permissions will eventually depend on the individual merits of the case.

## SPACE AND SKIN

*Microbial milieu:* About 50 species of microbes, mostly bacteria, reside in all orifices and persist despite washing and disinfecting. They are carried to the space along with the space traveler. Reduced atmospheric pressure, dilution and interpersonal exchange of microbes during space travel may make them pathogenic.<sup>[17]</sup> Because of the difficulty in bathing and maintenance of personal hygiene, outbreaks of pyodermas, viral infections and fungal infections may occur. A Soviet study has recommended bathing once in four days to allow natural homeostatic mechanisms to operate.<sup>[18]</sup>

*Immunological effects:* C3 levels are elevated; C4 levels remain unchanged; Immunoglobulin A, Immunoglobulin G, Immunoglobulin M levels are increased; Interferon alfa (IFN- $\alpha$ ) levels are raised; Interferon gamma (IFN- $\gamma$ ) levels are reduced; and T-cell responsiveness to mitogen and lymphocyte activation are reduced.<sup>[19]</sup> These may influence the host response to cutaneous infections or eczemas.

*Systemic physiological changes:* During space flight, the following physiological changes may occur: space motion sickness, muscle atrophy, bone loss, negative nitrogen balance, negative calcium balance, fluid shift to upper body, red blood cell loss, decrease in heart size, and increase in heart rate. After flight the physiological effects are: reduced exercise tolerance, reduced blood volume, postural hypotension and reduced cardiac output.<sup>[20]</sup>

*Cutaneous effects of space flight:* Skin diseases were leading in probability ranking for occurrence of disease during space flight but with the least mission effect.<sup>[21]</sup> Skin disorders expected in space flight are xerosis; risk of bacterial colonization; lowered resistance to viral and fungal infections; reduced cell mediated immunity; risk of malignancy from radiation exposure; impairment of wound healing; skin irritation due to fiberglass, skin infection, contact dermatitis and rash.<sup>[22]</sup>

Skin disorders reported in the literature are rash, contact dermatitis, boils, irritation from fiberglass, Tinea pedis by *T mentagrophytes*, Tinea cruris by *T rubrum*, extensive fissuring of fingertips, and primary irritant contact dermatitis to chest electrodes.<sup>[23]</sup>

Other concerns during space flight are resistance to antibiotics in flight; restrictions on powder form of drugs owing to pulmonary toxicity; restriction of alcohol/gel vehicles as they are flammable; special facilities for staining biopsies/culture; irritant/allergic potential of clothing fabric; shed hair and skin which are inhaled or clog vents; and showering vs. use of moist pads for personal hygiene.<sup>[24]</sup>

## SPACE TOURISM

On 30 April 2001, 60-year-old Dennis Tito and on 18 September 2006 Anousheh Ansari made history as the first male and first female space tourists respectively. Costing approximately \$20 million, their sojourn aboard Russian Soyuz rockets to the International Space Station and back, heralded the era of space tourism. The effects of microgravity, limited medicare capabilities and emergency ground egress add to the stresses of space flight. The duration of space flight, type of flight and cabin physiology may influence these effects. Hence, certain flights lend themselves to disqualification of a potential passenger for commercial

space travel from a dermatological standpoint. Low earth orbit flights, defined as those with orbits extending 160-2,000 km from the earth's surface, are prohibited to those with 'Severe skin disease, e.g. psoriasis, chronic pruritus, skin tumors that may interfere with use of life support equipment'.<sup>[25]</sup> Sub-orbital flights, defined as those in which the spacecraft reaches space, but its trajectory intersects the atmosphere or surface of the gravitating body from which it was launched and reaches an altitude just higher than 100 km above sea level, are prohibited to those with 'Communicable diseases'.<sup>[26]</sup>

## CONCLUSION

As men and women scale newer heights in aviation careers and space exploration, the array of interaction between the cutaneous integument and the aerospace environment is gradually unfolding itself. With technology preparing mankind for interplanetary travels in the not so distant future, this interface is still uncharted. Space may well be the final frontier, but the arena is still young and interaction between dermatology and the aerospace environment can only be ignored at our peril.

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### Multiple Choice Questions

1. The cosmic radiation exposure at 35000 feet altitude is \_\_\_\_\_ times more than that at sea level:
  - a. 10
  - b. 50
  - c. 100
  - d. 200
2. The dose of prednisolone restricting aviators from performing flying duties (as per existing guidelines) is:
  - a. 10 mg
  - b. 20 mg
  - c. 30 mg
  - d. 40 mg
3. A Soviet study has recommended bathing once in \_\_\_\_\_ days in space in order to maintain normal homeostatic mechanisms:
  - a. Daily
  - b. 2
  - c. 3
  - d. 4
4. Dermatological disorders comprised \_\_\_\_\_ % of all OPD attendance during World War II:
  - a. 75
  - b. 65
  - c. 50
  - d. 25
5. The commonest skin disorder in aero-medical consultations was:
  - a. Eczemas
  - b. Fungal infections
  - c. Bacterial infections
  - d. Malignancies
6. Aircrew are at a higher risk to cancer of prostate:
  - a. True
  - b. False
7. Patients with severe psoriasis could be disqualified for:
  - a. Sub-orbital flights
  - b. Low earth orbit flights
8. Irritants encountered by aircrew include:
  - a. Jet fuel
  - b. De-icing agents
  - c. Hydraulic agents
  - d. All of the above
9. N-phenyl-l-naphthylamine, the commonest irritant is a component of:
  - a. Jet fuel
  - b. De-icing agent
  - c. Hydraulic agent
  - d. Kerosene
10. The dermatological disorder less commonly expected in space flights includes:
  - a. Xerosis
  - b. Stasis dermatitis
  - c. Contact dermatitis
  - d. Leucocytoclastic vasculitis

1. c, 2. b, 3. d, 4. a, 5. b, 6. a, 7. b, 8. d, 9. a, 10. b  
**Answers**

#### Announcement

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