

Contact Dermatitis in Military Personnel

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Military personnel encounter the same allergens and irritants as their civilian counterparts and are just as likely to develop contact dermatitis from common exposures encountered in everyday life. In addition, they face some unique exposures that can be difficult to avoid owing to their occupational duties. Contact dermatitis can be detrimental to a military member's career if he or she is unable to perform core duties or avoid the inciting substances. An uncontrolled contact dermatitis can result in the member's being placed on limited-duty (ie, nondeployable) status, needing a job or rate change, or separation from military service. We present some common causes of contact dermatitis in military personnel worldwide and some novel sources of contact dermatitis in this population that may not be intuitive.

ECZEMATOUS DERMATITIS is the second most costly form of occupationally aggravated skin disease in the civilian world and for the Department of Defense.¹ For applicants to the US armed forces, such a condition is commonly disqualifying owing to its chronic nature and the likelihood of its being exacerbated by the demands of military service.² For patients who develop chronic and recalcitrant eczema while already on active duty, the condition can disqualify the member from certain more demanding rates or occupations, including duty involving aviation, diving, nuclear reactors, or Special Forces. If the condition is not well controlled and restricts a service member from acting at full capacity, a medical board review and potential discharge from service can result.

Evaluation should start with a detailed clinical history, specifically addressing the timing, pattern, exposures (occupational, hobby related), subtypes (such as hand dermatitis), hand-washing practices, right- or left-handedness, and risk factors (atopy, wet work). Deciphering whether the condition is primarily an irritant contact dermatitis or an allergic contact dermatitis is critical as these conditions can be eliminated with proper diagnosis and management.

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Irritant Contact Dermatitis

Irritant contact dermatitis (ICD) accounts for 80% of cases of contact dermatitis.³ In this type of reaction, the skin is exposed to an “injurious” substance, and a nonimmunologic response occurs with direct keratinocyte damage and inflammatory cytokine release.⁴ The occupational irritants most frequently reported by military personnel include alcohols, cutting oils and coolants, degreasers, disinfectants, petroleum products, soaps and cleaners, solvents, and wet work.^{3,5} Additional irritants specifically affect persons in military sectors (Table 1 and Table 2).^{6–8}

Beetle Dermatitis

In military operations that require extensive travel (often to remote areas of the world), outbreaks from unusual irritants can be expected. Irritant reactions to Meloidae (blister beetles), Oedemeridae (false blister beetles), and (frequently) Staphylinidae (rove beetles) have been reported in military personnel.⁹ Rove beetle dermatitis results from contact with pederin toxin after the incidental crushing of a beetle.⁹ This dermatitis can mimic the effect of some chemical warfare agents (specifically, mustard gas, lewisite, and herpes zoster).^{9–11} Rove beetles caused 191 cases (10% of base personnel) among US forces deployed to Pakistan for Operation Enduring Freedom in 2001,¹² 30 cases in May 2002 among special operations forces in Afghanistan,^{9,13} and 20 suspected cases of beetle dermatitis (also called dermatitis linearis) in 2007 at Joint Base Balad, Iraq.¹³ Dermatitis linearis typically affects personnel who work at night near artificial lighting; the head, neck, and extremities are most commonly affected.¹² Patients usually do not recognize the presence of the beetle. After exposure, they complain of a

Table 1. Civilian and Military Occupations at Risk for Irritant Contact Dermatitis

<i>Civilian*</i>	<i>Military*</i>
Nursing, medical work (15.9%)	Vehicle repair and maintenance (48%)
Service work (15.4%)	Food handling (19%)
Food handling	
Mechanical work	

Adapted from Magina S et al⁶; Goon AT and Goh CL⁷; Thyssen JP et al.⁸

*Percent prevalence of irritant contact dermatitis is noted in parentheses.

“burning” sensation at sites where the beetle contacted clothing or skin, and they eventually develop pustules with a “halo” of erythema and no systemic symptoms. The lesions heal in 7 to 10 days with transient hyper- or hypopigmentation.¹⁰

In the 2001 outbreak, management measures included spraying permethrin-based insecticides at the infested fitness center on two occasions. The base educated service members to sleep under mosquito netting, apply insect repellent, and avoid areas with a high beetle prevalence.¹² Davidson and colleagues also recommended modifying light sources because these beetles are less attracted to sodium vapor and halogen sources that emit yellow and orange light than to sources that emit ultraviolet and white light.⁹ Removing unnecessary lights and moving recreation and smoking-break areas away from white lights can also decrease soldiers’ exposure.⁹

Agave Dermatitis

Agave contact dermatitis involves exposure to the plant’s sap, which contains calcium oxalate crystals, acrid oils, saponins, agave gum, and other compounds.¹⁴ Several

Table 2. Top Irritants in Hand Dermatitis among Civilians and Military Personnel

<i>Civilians</i>	<i>Military Personnel*†</i>
Wet work	Oil and grease (66%)
Soaps	Wet work (23%)
Detergents	
Water	
Solvents	Solvents (18%)
Household solvents	
Turpentine	
Kerosene	
Gasoline	

*Data from Goon AT and Goh CL.⁷

†Percent prevalence is noted in parentheses.

researchers have described an “epidemic” of self-induced *Agave* dermatitis among Israeli soldiers, insinuating a form of malingering to avoid mandatory military service.^{15–18} According to the Israeli reports, the soldiers presented with an acute dermatitis with papules and pustules linearly on a larger erythematous patch. The majority of patients also experienced fever and leukocytosis, making the diagnosis of contact dermatitis more difficult; however, reports of flulike symptoms with systemic contact dermatitis do exist.^{15,19} This form of malingering offers the soldier the secondary gain of sick time off from the duties of military service. Also of interest, garlic, onion, and potatoes have been reported as possible causative agents for self-inflicted dermatitis artefacta in the military population.^{15,20,21} Understanding the “constraints” of mandatory military service or patients’ desires for secondary gain even with voluntary service can help the astute physician have a high index of suspicion for self-inflicted dermatoses.

N, N-Diethyl-meta-Toluamide Dermatitis

N, N-Diethyl-meta-toluamide (DEET) was first developed by the US Army at the end of World War II to prevent arthropod-borne diseases in jungle warfare. DEET is considered the most effective repellent of mosquitoes, blackflies, midges, fleas, and chiggers.^{22,23} Military personnel are deployed worldwide and are exposed to a plethora of arthropod-associated diseases. Although there are some vaccines for preventing infectious diseases such as yellow fever and Japanese encephalitis, some diseases (eg, leishmaniasis, malaria, dengue fever, and Q fever) are not covered by currently available vaccinations. The current Department of Defense (DOD) insect repellent system involves permethrin-impregnated uniforms and the use of DEET on the skin in addition to other measures (including the proper wearing of the uniform).²⁴

DEET rarely causes serious side effects but can cause eye and skin irritation and, in severe cases, blisters that result in scarring.^{25–27} Reuveni and Yagupsky reported 10 soldiers with ICD from DEET, all with involvement of the antecubital fossa.²⁶ A military person in the field often sleeps with his or her rifle; the antecubital fossa may become occluded during an overnight sleep, increasing the likelihood of an irritant dermatitis.²³ In addition, contact urticaria from DEET application has been reported.²⁸

Caterpillar Dermatitis

Caterpillar dermatitis (pityocampal erucism) has been reported worldwide. In the example of a British serviceman

deployed to Croatia, an intensely pruritic eruption of acute onset developed on his face and neck and above his hairline posteriorly after he handled a large pine recessionary caterpillar (*Thaumetopoea pityocampa*) at his barracks.²⁹ This case underlines the importance of having a high degree of clinical suspicion for a unique irritant and gathering a thorough history as part of a complete evaluation.

Allergic Contact Dermatitis

Allergic contact dermatitis (ACD) differs clinically from ICD (Table 3).^{4,5} As with ICD, the chemicals that cause ACD in civilians can also cause ACD in military personnel. For example, Wolf and colleagues found that 27% of soldiers with hand dermatitis were patch test positive to one or more allergens in the North American standard series.³⁰ However, by performing tailored supplemental patch tests where indicated, they found that 29% of the soldiers were patch test positive to one or more allergens in the oil series, which would have been missed on initial screening with just the standard series. These data support the use of tailored patch testing based on individual's exposures to increase pretest probability of a relevant positive patch test at initial screening.³⁰

The Thin-layer Rapid Use Epicutaneous (T.R.U.E.) Test (Mekos Laboratories A/S, Hillerød, Denmark) is a Food and Drug Administration–indicated commercially available diagnostic patch test kit that uses 29 allergen components, including simple allergens, allergen mixes, and a negative control. Henning and colleagues evaluated the use of the T.R.U.E. Test in a combat environment.³¹ Of 30 patients tested in Baghdad, Iraq, between January 2008 and July 2008, 14 (46.7%) had positive patch-test reactions to one or more allergens. The most frequently positive reactions were to nickel (17%), neomycin (17%), and thimerosal (17%). Other agents that yielded positive results in this population included budesonide, epoxy resin, potassium dichromate, p-phenylenediamine,

formaldehyde, quaternium-15, fragrance, and balsam of Peru. Another four patients reacted positively to bacitracin (an allergen not on the T.R.U.E. Test) on use testing. This retrospective analysis showed that the T.R.U.E. Test may be an efficient, easy, and clinically relevant method of testing for ACD in the combat environment.³¹ Of note, some allergens are typically missed, including occupational chemicals, some corticosteroids, disperse dyes, some preservatives, and detergents.

Nickel is the most common allergen for both the civilian and the soldier in combat.^{31,32} This ubiquitous metal is found in a wide range of products, from paperclips, keys, and coins to clothing (eg, jean snaps, zippers, eyelets, and underwire bras), cell phones, and medical devices (eg, insulin needles and stents). As well, there are sources associated with the military commission; for example, the belt buckle issued by the US Navy is currently made of nickel. Of interest, the use of nickel in Navy identification-tag chains has largely been phased out.³³

Deciding whom and with which allergens to patch-test requires experience and triaging, especially in the field. Guidelines on which patients would most likely benefit from diagnostic patch testing are provided by Table 4.

ACD from Military Uniforms

Contact dermatitis can result from exposure to military uniforms. This can present unique challenges, given the strict uniform requirements of military service. Many chemicals in military uniforms (including formaldehyde resins, disperse dyes, and chromate-containing dyes) are capable of causing ACD.

Formaldehyde-based resins can be found in wrinkle-resistant, permanent-press, rayon, and corduroy textiles. In the recent past, it was thought that free formaldehyde levels in most clothing were so negligible that even formaldehyde-allergic individuals would not react.^{15,34} In the 1980s, the Consumer Product Safety Commission

Table 3. Comparison of Clinical Features of Irritant and Allergic Contact Dermatitis

	<i>Irritant</i>	<i>Allergic</i>
Latency of reaction	Usually within 48 hours	Delayed (many hours to 5 to 6 days)
Demarcation	Typical—most often limited to area of exposure	May occur but generally spreads beyond area of exposure
Resolution	Frequently diminished by 96 hours	Many days, weeks, or months
Clinical snapshot	May look like repetitive hand washing	May look like poison ivy reaction
Diagnostic basis	History	Patch testing

Adapted from Beltrani VS and Beltrani VP⁴; Warshaw EM.⁵

Table 4. Guidelines on Consideration for Patch Testing

<i>Reasons to Patch-Test</i>	<i>Reasons Not to Patch-Test</i>
New-onset dermatitis	Informed consent not obtained
Progressing or deteriorating dermatitis	Patient unwilling to comply with patch-test procedure
Changing pattern; increased body surface area	Patient unwilling to avoid allergic substances if found
Involvement of specific sites (ie, face, eyelids, hands, neck folds)	Another diagnosis by history (ICD, stable psoriasis, stable atopic dermatitis, keratoderma)
Clinical presentation of dyshidrosis	Erythroderma
Dermatitis clears only with potent topical or oral steroids	Absence of itching
High index of suspicion for contact dermatitis	

ICD = irritant contact dermatitis.

reviewed the amount of formaldehyde in clothing and did not see a significant public health concern. However, most clothing was made in the United States at that time. With markets in Asia now producing a much greater percentage of imported textiles, the Government Accountability Office recently reviewed formaldehyde levels in 180 items and found that US military combat uniform pants targeted for women exceeded the regulatory standards for formaldehyde, whereas the same pants targeted for men met the standards.³⁵ Although military uniforms continue to be manufactured in the United States, these results suggest that free formaldehyde levels in military textiles may be higher than previously reported. In addition, the military does not regulate undergarments or T-shirts closely. These items may be purchased outside of base uniform shops and are more than likely manufactured overseas in today's versatile market.

ACD from the new US Army combat uniform has been reported in young active-duty personnel. The dermatitis did not resolve with numerous washings of the uniform and subsided only with discontinued use. In one case, the person reacted positively to the p-tert-butylphenol formaldehyde resin used in after-manufacturing modifications to impart a wrinkle-free appearance to the clothing and decrease shrinkage.³⁶

Chromate has been reported as a cause of ACD from green military uniform sweaters and pants. Chromate is used in textile dyeing to help fix dye onto clothing fibrils and impart a wrinkle-free appearance. Analysis showed that even after numerous washings, there was a sustained release of chromate from the uniforms.³⁷

ACD from Military Camouflage

Military camouflage remains an essential tactical component of combat operations, helping to blend an individual with the surroundings. In one example, a 20-year-old army recruit developed contact dermatitis from the application

of green face-paint camouflage with a wax stick (resembling lipstick) containing 47.1% castor oil.³⁸ The ingredients of concern were ricinoleic acid (a derivative of castor oil), butylated hydroxytoluene, butylated hydroxyanisole, octyl gallate, and propyl gallate. Both the use test with the camouflage stick and the patch test with 30% ricinoleic reacted positively, indicating an allergy.³⁸ Many military members still use this tactical camouflage face-painting technique and expose themselves to potential allergens.

ACD from Industrial Fluids

Military maintenance workers encounter industrial fluids that can cause ICD, but these fluids may also cause allergic dermatitis, which may be more common than expected. A study of the Israeli military from 2000 to 2003 revealed 102 cases of contact dermatitis: 60 patients (58.5%) had ICD, and 42 patients (41.2%) had ACD. Of the patients with ACD, 33 (78.6%) were maintenance workers. Twenty-five of the patients reacted to oil and cooling fluids; 14% of the reactions were attributed to methylchloroisothiazolinone/methylisothiazolinone (a common preservative in lotions and shampoos as well).³⁹

ACD from Shrapnel

Shrapnel is defined as a projectile that explodes in flight.⁴⁰ Shrapnel embedded in improvised explosive devices accounts for the vast majority of military morbidity and mortality in Operation Enduring Freedom and Operation Iraqi Freedom. Many wounded soldiers return from the field with shrapnel embedded at sites from which it is too risky to remove. Given the other challenges these soldiers face (traumatic brain injuries, posttraumatic stress disorder, and more serious physical injuries), dealing with the remaining shrapnel presence is often an afterthought. In a

recent study, veterans of the first Gulf War with embedded shrapnel were found to have stronger cutaneous reactions to metals; 25% reacted to zinc and 12.5% reacted to manganese, compared with 8.5% and 6.5%, respectively, in a control group. Reactions were greater in veterans with shrapnel in their combat wounds than in veterans without shrapnel fragments. These patterns of sensitivity accord with the metal components of the shrapnel extracted from the wounds of the soldiers and reveal a unique source of allergens.^{41,42}

Allergic Reactions to Vaccines

Basic training in the military involves drill, rigorous physical training, the learning of commands, and being vaccinated. Besides the standard series of vaccinations typically given in public schools and to medical personnel, certain additional vaccinations (eg, meningococcal and influenza vaccines) are deemed necessary, especially considering the close living conditions mandated in training. Other vaccines are mandated for those entering an endemic area (eg, yellow fever and Japanese encephalitis virus vaccines) or an area with a high threat of biologic attacks (eg, anthrax and smallpox vaccines).

In 2002, the Centers for Disease Control and Prevention established the Vaccine Analytic Unit in collaboration with the DoD to develop an anthrax vaccine safety research plan. Over 100 potential adverse events were identified, and the following adverse-event topics were selected for further study: arthritis, optic neuritis, Stevens-Johnson syndrome, and toxic epidermal necrolysis. Of note, systemic lupus erythematosus and “multiple near-concurrent military vaccinations” were added in response to emerging public health and military concerns.⁴³ Notably, the anthrax vaccination is a six-part series of injections, the first three injections being previously administered at 2-week intervals. More recently, the second injection of the series was deleted, making 4 weeks the shortest interval between injections.

Note that a number of vaccine components may sensitize patients; these components include phenoxyethanol, formaldehyde, neomycin, aluminum, and thimerosal. Because a higher incidence of autism was seen as vaccines became more prevalent,^{44,45} many have questioned the role of thimerosal, which resulted in the removal of thimerosal from most pediatric injectable vaccines in the United States. However, it is still used worldwide in inactivated influenza virus vaccine, Japanese encephalitis virus vaccine (JE-VAX, Ixiaro, Livingston, Scotland), pneumococcal vaccine (Pnu-Imune 23, Lederle Laboratories, Pearl

River, NY), tetanus toxoid, *Haemophilus* B conjugate vaccine (HibTITER, Wyeth-Ayerst, Philadelphia, PA), *Haemophilus* B conjugate and hepatitis B vaccine, influenza virus vaccines, and many of the multi-dose vials of flu vaccine, most of which are required for all US armed services personnel.⁴⁶

The reinstitution of smallpox vaccination resulted in military physicians’ seeing significant numbers of adverse events for the first time since the 1980s. The Department of Dermatology of Darnall Army Community Hospital has reported three distinct hypersensitivity-reaction patterns among 11,058 vaccinees: exanthematous type (6 patients), erythema multiforme-like type (1 patient), and urticarial type (2 patients). The exanthematous type of hypersensitivity reaction is a newly reported type of reaction to the smallpox vaccine, suggesting that hypersensitivity reactions may be occurring at a rate higher than previously reported.⁴⁷

Conclusion

Active-duty military personnel clearly encounter some novel sources of ICD and ACD. Differentiating these two conditions from other eczemas can be a challenge but is essential for proper management. Military physicians need to have a high clinical suspicion for common irritants and allergens causing dermatitis but also must consider unique sources of exposure in a military member’s environment, including arthropods, plants, and mandatory personal protective gear (DEET, masks, rifle stance, and uniforms), as well as the tours of duty military personnel perform (such as patrolling outdoors at night), which lead to new sources of exposures. With an understanding of the unique risks and exposures comes the ability to take reasonable measures to avoid both irritant and allergenic chemicals. For example, DEET application can be minimized to areas that might become occluded, such as the antecubital fossa; better still, long sleeves or mosquito netting could be implemented as preventative measures. Personnel can be educated to avoid handling arthropods that may result in irritation, and wearing the uniform properly can help reduce inadvertent exposure.

Alternate uniforms do exist. When necessary, avoidance of a particular uniform article could be ordered (at the commanding officer’s discretion) to maintain good order and discipline among troops. Ultimately, ACD from a uniform-based chemical could result in administrative or medical separation from duty, especially if not diagnosed early and if available alternatives are implemented late. Access to local resources is a limiting factor while

personnel are deployed; if allergy is detected before deployment, there is a greater likelihood that personnel will be able to find an alternative camouflage source owing to the wider range of resources available.

Military personnel are exposed to many dangers in combat, and the embedding of shrapnel does occur. This shrapnel may put them at increased risk for sensitization to metals and may result in chronic dermatitis. Finally, military service requires numerous vaccinations above and beyond those offered to the general public, increasing the exposure of military personnel to potentially sensitizing agents such as aluminum, formaldehyde, and thimerosal.

Active-duty military personnel face many unique challenges in addition to their combat requirements, including how to adequately perform with a diagnosis of contact dermatitis. The foremost challenge remains precise and accurate diagnosis, especially in the field. Unfortunately, there are occasions when the dermatitis compromises the safety and well-being of the member and his or her fellow troops, warranting separation. With increased awareness of contact dermatitis in military medicine, these separations could be minimized as safer preventative measures and alternatives are adopted.

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