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INSECT REPELLENTS

Insect repellents have been used on the skin for many years, primarily to prevent mosquito bites, which transmit malaria, West Nile virus infection, and various types of encephalitis. With increased concern about Lyme disease in recent years, skin and clothing repellents are now also recommended for protection against ticks.

DEET — N,N-diethylmetatoluamide, commonly called DEET, repels a variety of mosquitoes, chiggers, ticks, fleas and biting flies; no topical repellent is effective against stinging insects, such as bees and wasps. In the United States, DEET is available in formulations of 5%-40% and 100%. DEET products containing less than 20% can provide complete protection for 1-3 hours. Higher concentrations provide longer-lasting protection (up to 12 hours), but the duration of effect reaches a plateau at concentrations higher than 50%.

A long-acting DEET formulation, originally developed for the US Armed Forces (US Army Extended Duration Topical Insect and Arthropod Repellent, EDTIAR) is available in the US as *Ultrathon* (3M); it contains 25% or 33% DEET in a long-acting polymer formulation, which prevents loss from the skin surface through absorption and evaporation. This product provided more than 95% protection against mosquito bites for 6 to 12 hours, depending on environmental conditions and the species of mosquito, which was similar to the effect of 75% DEET in an alcohol base (RK Gupta and LC Rutledge, *J Am Mosq Control Assoc* 1991; 7:490).

OTHER REPELLENTS — None of the presently marketed alternatives to DEET offer a similar duration of protection. Citronella-based repellents (*Natrapel*, and others) provide short-term protection against mosquitoes (less than 1 hour), but are probably not effective against ticks. A recently marketed eucalyptus-oil-based repellent (PMD; *Repel Lemon Eucalyptus*, and others) provided up to 4 hours' protection against mosquitoes in a field study (DR Barnard et al, *J Med Entomol* 2002; 39:895). In a laboratory study, non-DEET products provided only a short duration of protection: about 20 minutes with citronella as the active ingredient, 23 minutes with the alanine analog IR 3535 (*Skin-So-Soft Bug Guard Plus*), and 95 minutes with soy bean oil (*Bite Blocker*) (MS Fradin and JF Day, *N Engl J Med* 2002; 347:13).

One new product, picaridin (KBR3023; Bayrepel; *Autan Repel*, and others — SC Johnson), a piperidine derivative that is already available in Europe and Australia and will soon be marketed in North America, may prove to be as effective as DEET. In a controlled field trial, 19.2% picaridin was as effective against mosquitoes (>95% protection for 8 hours) as US Army EDTIAR (SP Frances et al, *J Med Entomol* 2002; 39:541).

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PERMETHRIN — A contact insecticide rather than a repellent, permethrin is used for treatment of lice (*Nix* — Medical Letter 1986; 28:89) and is also marketed as a solution or spray (*Repel Permanone*, and others) for application to clothing, mosquito nets, tents and sleeping bags to protect against both mosquitoes and ticks. Permethrin is more effective than DEET against ticks (Medical Letter 1989; 31:45). Wearing permethrin-treated clothing and applying a DEET-containing repellent to the skin may be the most effective way to prevent insect bites. Permethrin is non-staining, nearly odorless and resistant to degradation by light, heat or immersion in water; treatment of clothing can persist through 20 or more washings.

SAFETY — DEET can damage clothes made from synthetic fibers, and plastics on eye-glass frames and watch crystals (EA Mafong and LA Kaplan, *Postgrad Med* 1997; 102:63). Despite some earlier concerns, toxic and allergic reactions to DEET have been uncommon, and serious adverse effects are rare. Used as directed, concentrations up to 50% appear to be safe, even in young children. Toxic encephalopathy has occurred, usually with prolonged or excessive use in infants and children, sometimes including ingestion of the product. Rash ranging from mild irritation to urticaria and bullous eruptions has been reported, and patients find some DEET formulations uncomfortably oily or sticky on their skin. DEET has been used safely in the second and third trimester of pregnancy (R McGready et al, *Am J Trop Med Hyg* 2001; 65:285). Picaridin apparently does not irritate the skin or damage synthetic fibers; no serious reactions have been reported to date. Permethrin is toxic to the nervous system of insects, but in mammals it is poorly absorbed and then rapidly inactivated by ester hydrolysis. Objective signs of skin toxicity such as edema, erythema and rash have been uncommon, and adverse systemic effects have not been reported.

CONCLUSION — DEET-containing insect repellents, especially the long-acting EDTIAR formulation, can prevent mosquito and tick bites and are generally safe. Wearing protective clothing treated with permethrin in addition to using DEET on exposed skin may be the best protection against mosquito and tick bites. Picaridin, not yet available in the US, might prove to be as effective as DEET without damaging synthetic fibers or causing skin discomfort.

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