Insect Precautions

Traveler Summary

Key Points

- Significant and potentially life-threatening illnesses can be transmitted by insect and other biting vectors.
- Wear protective clothing (e.g., long sleeves, trousers, and socks) as a first line of defense.
- Apply an EPA-approved insect repellent (e.g., DEET 30%–35% concentration or Picaridin 20% concentration) on all exposed skin. These repellents have the most data supporting effectiveness; avoid other repellents (including botanicals) for tropical diseases. Repellent should be applied to the face using hands (not spray), avoiding mouth and eye areas.
- Treat clothing with permethrin by fully saturating the fabric and allowing it to air dry; this will increase the protective level of clothing by repelling flying insects (mosquitoes, flies) and killing crawling arthropods (ticks, mites, fleas).
- Reapply repellent frequently and after strenuous activity or swimming.
- Avoid combination repellent-sunscreen products because the effectiveness of the sunscreen may be diminished.
- Apply sunscreen before repellent, allowing the sunscreen to fully dry. Sunscreen may increase absorption of DEET.
- Know what insects are prevalent, what time of day they are active, and where they can be found. In some locations, precautions may need to be employed 24 hours/day due to multiple threats.
- Do a full body check for ticks during and after outdoor activity and at the end of each day; promptly remove any ticks found.
- Sleep in rooms with intact screens, bed nets, or air conditioning.
- Use an insecticide spray, vaporizer, or coil to kill stray insects in sleeping quarters.

Introduction

In the tropics, insects and other biting vectors can transmit significant illnesses (such as chikungunya, dengue, malaria, rickettsial disease, yellow fever, and Zika), which may be potentially life threatening. These diseases are preventable with the use of personal protective measures. In some cases (e.g., malaria or yellow fever), a preventive drug or vaccine is also available, but these should be used with the personal protective measures discussed below.

Personal Protective Measures

Travelers should:

- Wear clothing that covers as much skin as practicable, especially when walking through brushy vegetation.
- Wear long, light-colored pants tucked into socks when traveling in an area with risk for tick-borne diseases; light-colored clothing makes it easier to spot ticks.
- Apply a repellent to all exposed, nonsensitive areas of the body. Frequent application ensures continuous protection. When both an insect repellent and sunscreen are used, apply the sunscreen first, letting it dry completely, then apply the repellent. Very limited data suggest that DEET-containing repellents reduce a sunscreen's stated SPF UVB protection by as much as one-third, requiring more frequent sunscreen application. Sunscreens do not appear to reduce the efficacy of insect repellents (DEET or picaridin) but may increase the absorption of DEET (but not picaridin) through the skin, even when the sunscreen is applied first as recommended. Avoid use of a combination sunscreen/insect repellent product (e.g., Avon Skin Soft Bug Guard, Bull Frog Mosquito Coast Sunscreen with Insect Repellent, or Sunsect).
- Use a repellent containing DEET (N,N-diethyl-meta-toluamide; 30%–35% concentration) or, alternatively, a repellent containing picaridin (20% concentration or greater for tropical destinations; also known as icaridin). Picaridin, unlike DEET, has a pleasant smell and does not dissolve plastic materials.
- Determine the time of day and type of insects to be avoided when choosing when to apply repellent.
    - ***Applicable to malaria risk countries:*** Mosquitoes that transmit malaria (***Anopheles*** spp.) are generally night biters with activity between dusk and dawn.
    - ***Applicable to West Nile virus and Japanese encephalitis risk countries:*** Mosquitoes that transmit these diseases (***Culex*** spp.) are generally night biters but have peak activity at dusk and again at dawn.
    - ***Applicable to chikungunya, dengue, yellow fever, or Zika risk countries:*** Mosquitoes that transmit these diseases (***Aedes*** spp.) can bite throughout the day but have peak activity in the early morning, late afternoon, and evening.

    - ***Applicable to leishmaniasis risk countries:*** Sand flies that transmit leishmaniasis are active from dusk to dawn, but in forests and dark rooms they may bite in the daytime if disturbed.
    - ***Applicable to African trypanosomiasis risk countries:*** Tsetse flies can bite through lightweight clothing. DEET and permethrin are generally ineffective. Wear light-colored (not blue), heavyweight clothing in risk areas.
- Treat outer clothing, boots, tents, and sleeping bag liners with permethrin (or other pyrethroid) when traveling in an area of very high risk for mosquito-borne or tick-borne diseases.
- Sleep under a permethrin-impregnated bed net when at high risk of malaria or Japanese encephalitis if not sleeping in a sealed, air-conditioned room. Regularly check the net for rips and tears and keep it tucked in around the bed at all times. Ensure that all open windows have insect screens.
- Use spatial repellent products in the form of an aerosol spray, vaporizer device, or smoldering coil. These products usually contain a pyrethroid (e.g., metofluthrin or allethrin).
- Perform a full body check (especially the neck, scalp, groin, armpits, and navel) for adult ticks and nymphs during and after outdoor activity and at the end of each day when staying in an area with risk for tick-borne diseases. Remove attached ticks immediately, preferably with forceps or with fine-tipped tweezers, grasping the tick as close to the skin surface as possible and pulling directly upward, steadily, without twisting or jerking. Clean the site with an alcohol swab or soap and water. Avoid handling the tick with bare hands.

Insect Repellents and Insecticide-Treated Clothing

The most effective repellents contain DEET or picaridin. Picaridin is considered to have comparable efficacy and duration of protection to DEET at the same concentration. Both compounds have been shown to be effective (under actual field conditions in tropical countries) against both ***Anopheles*** and ***Aedes aegypti*** mosquitoes.

Besides DEET and picaridin, the US Environmental Protection Agency (EPA) has registered several other active ingredients as repellents, but fewer studies have been conducted (compared to DEET and picaridin) to examine their efficacy and data on 2-undecanone are limited compared to other second-line repellents. The newest active ingredient, nootkatone (developed by US CDC), is registered for use in insecticides and insect repellents; however, the time for development of new products containing nootkatone and subsequent EPA review mean commercial availability of products is not expected immediately and no products were available as of early 2022. Data suggest 85% to 90% efficacy in repelling mosquitoes (***Aedes***, ***Culex***, and ***Anopheles*** species) compared to DEET (20%) and superior efficacy at repelling ticks compared to DEET, picaridin, and IR3535. In addition to repelling ticks and mosquitoes, nootkatone also kills them. Nootkatone is found mainly in grapefruit skin and is already approved as a safe flavoring and fragrance agent in the US and worldwide.

Common commercially available insect repellent brands for each active ingredient include:

- DEET: Off! Deep Woods Sportsmen, 3M Ultrathon lotion, Repel, Sawyer Ultra 30 lotion, Ben's Eco Spray, Cutter Backwoods, Sunsect
- Picaridin: Cutter Advanced, Natrapel, and Sawyer's Picaridin Insect Repellent
- IR3535 (chemical name: 3-[***N*** -butyl-***N*** -acetyl]-aminopropionic acid, ethyl ester): Bullseye, Avon's Skin So Soft Bug Guard Plus Expedition, and Coleman's SkinSmart
- Oil of lemon eucalyptus (OLE) or PMD (chemical name: para-menthane-3,8-diol), the synthesized version of OLE: Cutter Lemon Eucalyptus, Off! Botanicals, Repel
- 2-undecanone (chemical name: methyl nonyl ketone): BioUD

The following repellent products are approved for use by the US Department of Defense.

- DEET: Ultrathon lotion (34%), Sawyer Ultra 30 lotion (30%), Cutter Backwoods (25%), and Sunsect (20% plus SPF 15 sunscreen)
- Picaridin: Natrapel (20%)
- IR3535: Bullseye (20%)
- Sulfur: Chigg-Away (10% sulfur and 5% benzocaine) for chiggers

An increasing number of botanical repellents containing eucalyptus, citronella, soybean oil, geranium oil, and castor oil are marketed. Limited data suggest that these may be adequate alternatives to DEET or picaridin.

Use of brand names is for informational purposes only and does not constitute preference for one brand over another.

Duration of protection : With both DEET and picaridin, increasing repellent concentration increases the duration of effectiveness. With DEET, the effect on duration of protection plateaus at about 50% concentration. Products with less than about

20% picaridin or DEET have a relatively short duration of protection. The optimal concentration of DEET is considered to be 30% to 35%. When used by tropical travelers in appropriate concentrations (i.e., 20% or greater), DEET and picaridin should be applied every 4 to 6 hours. Ultrathon (34% DEET) and Sawyer's Ultra 30 (30% DEET) controlled-release lotion formulation provides protection for 10 to 12 hours.

Use in children : Both DEET and picaridin-containing repellents can be used in children 2 months and older; the maximum concentrations that should be used are 30% for DEET and 10% for picaridin. IR3535 and 2-undecanone can be used in children 2 months and older, and OLE can be used in children 3 years and older.

Use in pregnancy and breastfeeding : Pregnant women and their babies are at special risk from the consequences of vector-borne diseases. Clothing should cover as much skin as practicable, leaving only extremities, head, and neck exposed. DEET, picaridin, IR3535, OLE, and 2-undecanone can be used by pregnant and breastfeeding women but should not be applied directly to the nipple area to prevent ingestion by breastfeeding children. DEET has been shown in 1 short-term study to be safe in the second and third trimesters of pregnancy when used at concentrations of 20% or lower; however, the use of DEET in the first trimester has not been well studied. Although no evidence exists that the use of DEET or picaridin by pregnant or breastfeeding women poses a health hazard to unborn babies or children who are breastfeeding, no long-term follow-up studies are available.

Safety : DEET is effective against mosquitoes, ticks, fleas, and chiggers and is a remarkably safe insect repellent. Only 30 cases of severe toxicity have been reported among billions of uses over 30 years. Most cases of toxic encephalopathy or seizures were reported in young children in whom excessive amounts were used over prolonged periods. No long-term information is available on the use of picaridin, but toxicity tests in animals have shown it to be extremely safe.

The following precautionary measures can minimize the possibility of adverse reactions to insect repellents containing DEET or picaridin:

- Use repellents according to label directions.
- Apply repellents sparingly and only to exposed skin.
- Repellents should not be inhaled or ingested, and contact with the eyes should be avoided.
- Avoid applying repellents to portions of children's hands that are likely to have contact with eyes or mouth.
- Never use repellents on wounds or irritated skin.
- Wash repellent-treated skin if no further risk exists of exposure to insects.
- Wash treated skin and seek medical attention if a suspected reaction to insect repellent occurs.

Use a pyrethroid-containing aerosol spray, vaporizer device, or smoldering coil in living and sleeping areas during evening and nighttime hours.

Permethrin is an insecticide licensed for use on clothing, bed nets, sleeping-bag liners, and outdoor gear to repel mosquitoes and biting flies and to kill (through contact toxicity) crawling arthropods, such as ticks, chigger mites, fleas, and lice. Permethrin is available as a spray or as a liquid for complete immersion of the fabric to be treated. Permethrin physically binds to fabric (cotton or 50% cotton/nylon blend), retaining repellency even after 50 washings. To maintain contact toxicity and maximum protection, consider retreating clothing every 6 weeks or after every sixth laundering. Clothing treated with permethrin only provides protection on the covered portion of the body; therefore, a repellent applied to exposed skin should also be used. Permethrin is poorly absorbed through the skin, although sunscreens and other products may increase the rate of skin absorption. Another pyrethroid, deltamethrin liquid, is available in some countries.

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