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Mosquito repellents for travellers

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This is one of a series of occasional articles on therapeutics for common or serious conditions, covering new drugs and old drugs with important new indications or concerns. The series advisers are Robin Ferner, honorary professor of clinical pharmacology, University of Birmingham and Birmingham City Hospital, and Albert Ferro, professor of cardiovascular clinical pharmacology, King’s College London. To suggest a topic, please email us at practice@bmj.com.

Case scenario

A pregnant woman visits you as her general practitioner (GP) because she and her children will be visiting a country with mosquito borne disease. You recommend using repellents to protect against mosquitoes, as well as vaccinations and other relevant disease prevention measures. She asks which repellents would be best.

What are the active ingredients?

The key factors to consider when choosing a repellent are the active chemical ingredients and the strength (concentration (%)) of active ingredient because these influence the efficacy and duration of protection.¹² There are four active ingredients with sufficient published scientific evidence to warrant recommendation. Repellents are useful in areas of low risk of mosquito borne disease to prevent nuisance biting (which may lead to problems such as allergies) and are essential in moderate to high risk areas (figure⇓) to prevent disease transmission (such as malaria and dengue fever) through bites. Repellents work on mosquitoes by directly stimulating avoidance behaviour or by blocking the mosquito’s receptors for attractive odours, not though toxicity.³

DEET—N,N-Diethyl-meta-toluamide has been in use since 1946 and is the “gold standard” repellent recommended by the World Health Organization Pesticide Evaluation Scheme.⁴

PMD—Many people prefer the idea of a “natural” repellent to a synthetic one. p-Menthane-3,8-diol (PMD) was first isolated as a byproduct of Eucalyptus citriodora (lemon eucalyptus).

Icaridin—Icaridin (hydroxyethyl isobutyl piperidine carboxylate) is also known by the trade names Bayrepel, Picaridin, and Saltidin.

Insect Repellent 3535—IR3535 (ethyl butylacetylaminopropionate) is a synthetic repellent that has been less comprehensively studied.

How well do repellents work?

Although this article focuses on mosquitoes, the four recommended active ingredients may also protect against other arthropod vectors, such as sand flies and ticks. The recommended active ingredients should repel up to 100% of mosquitoes of the genera Aedes, Anopheles, and Culex for a specified duration. Although some repellents can last up to 12 hours, the average is 4-8 hours, depending on the active agent, application type, and the local mosquito species.²

DEET—For disease endemic countries DEET should be present at 20-50% concentration, because several large well conducted randomised control trials have shown that this concentration offers complete protection by repelling 100% of Aedes, Culex, and Anopheles mosquitoes for 6-13 hours.¹²

PMD—Repellents with 30% PMD provided complete protection for 4-6 hours against Aedes, Culex, and Anopheles mosquitoes in randomised controlled trials.¹² Apart from its shorter duration of action, efficacy is similar to DEET.

Icaridin—Like DEET, in randomised controlled trials in the field, at concentrations greater than 20%, Icaridin offered complete protection for up to six hours against Anopheles, Aedes, and Culex species.¹

IR3535—This has shown complete protection, comparable to DEET, at 20% concentration against several mosquito species including Aedes and Culex for 7-10 hours in well...
The bottom line

- Always recommend a topical applied repellent with a proven active ingredient such as DEET (20-50%), PMD (30%), or Icaridin (20-50%), IR3535 (20%) is recommended only for areas that are not malaria endemic.
- Reapply repellents at least every six to eight hours if using DEET or IR3535, or every four to six hours for PMD and Icaridin, and sooner if they wear off while swimming or sweating in warm weather.
- DEET can be used on children over 8 weeks old, PMD on children over 3 years.
- DEET is safe for use from the second trimester onwards and while breast feeding.

How are they used?

Recommend topical repellents, such as lotions and sprays, because they are the most studied and have the greatest efficacy. The repellent should be effective against the vector species present at the destination. Thus, although all four repellents are effective, do not recommend IR3535 for malaria endemic regions, given its shorter duration of action against Anophelos spp. Apply evenly to all exposed skin except the face (to avoid accidental eye exposure or ingestion) during times of risk (at dawn, dusk, and evening for most regions, but also during the day, particularly in South East Asia, South America, and in forested areas). Although every product is different, as a general rule, re-apply DEET and IR3535 every six to eight hours, and PMD and Icaridin every four to six hours. The tips for travellers box provides more detail on appropriate use.

How do they compare with alternatives?

An RCT compared common commercial products containing essential oils, vitamin B6, or the insecticide metofluthrin, in different delivery systems, including wristbands, stickers, patches, sonic devices, and diffusers. It found that only the personal diffusers containing metofluthrin or a mix of essential oils had any repellent effect, reducing localised biting by 87-95%. There is no evidence that any of these devices provide adequate protection for areas with mosquito borne disease. Other active ingredients include essential oils such as citronella, neem, thyme, geraniol, peppermint, patchouli, and clove. Because these compounds are volatile, efficacy is variable. They may provide 20-100% protection for about two hours, but a recent systematic review of laboratory and field trials found no evidence that they can protect against disease transmission. There is anecdotal evidence that a change in diet and vitamin supplements can protect against mosquito bites. Although this has not been looked at extensively, an RCT of the effect of vitamin B6 on human odour showed that it has no effect on mosquito biting rates. A double blinded RCT that tested the effect of garlic supplements as mosquito repellents found no protective effect. Intake of supplements like vitamin B6 or garlic should not be recommended for protection against mosquitoes.

Outcome

You recommend a topical repellent with DEET (20-50%) because it is effective and safe for pregnant women and children and provide advice on how to apply it (see tips for travellers box).

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Tips for travellers

Use a repellent containing 20-50% DEET or icaridin, or 30% PMD. Use IR3535 (20%) only if travelling to a country without malaria. Higher concentrations of DEET will repel mosquitoes for longer than lower concentrations. However, products with greater than 50% DEET are not recommended.

Essential oils such as citronella, repellent wristbands, garlic supplements, and vitamin B₆ do not provide adequate protection against biting and disease transmission.

Apply repellent evenly to all exposed skin except the face, particularly when there are lots of mosquitoes, such as in the early morning and the evening, but also during the day if mosquitoes are present. DEET and IR3535 should be reapplied every six to eight hours, and PMD and Icaridin every four to six hours, unless stated otherwise on the label. If swimming or sweating in warm weather, they may wear off sooner and will need to be reapplied.

Apply repellent and sunscreen simultaneously or repellent first; if using a combination product, check that it contains the right concentration of repellent (20-50% DEET).

You can safely use DEET when pregnant (from the second trimester onwards), when breast feeding, and on children over 2 months old. Thoroughly cover the child’s exposed skin (except the face), not clothing, and ensure that you wash it off before bed.

Additional resources: www2.epa.gov/insect-repellents; wwwnc.cdc.gov/travel/page/avoid-bug-bites

Competing interests: We have read and understood BMJ policy on declaration of interests and declare the following interests: JGL, VC-H, and SAS are employees of the Arthropod Control Product Test Centre, a wholly owned subsidiary of the London School of Hygiene and Tropical Medicine that performs independent efficacy testing of repellents for commercial companies. The other authors have no competing interests.

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Patient consent not required (patient anonymised, dead, or hypothetical).

8 WHO. I, cSM, H, E, (IM) eropa RE, d, a, (D) an P, M, E, Su, 0, 1, 2, and SAR are employees of the Arthropod Control Product Test Centre, a wholly owned subsidiary of the London School of Hygiene and Tropical Medicine that performs independent efficacy testing of repellents for commercial companies. The other authors have no competing interests.

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Figure

Areas of low, moderate, and high risk of mosquito borne disease worldwide