

odorless and, in contrast to DEET, is not harmful to synthetic fabrics.

Recommendation. Picaridin is an effective tick repellent and is comparably efficacious to DEET. Recommendation grade: 1B.

Recommendation. Picaridin may have a superior safety profile when compared to DEET. Recommendation grade: 2B.

Permethrin

Permethrin is both a repellent and an insecticide that is impregnated into clothing. Permethrin-treated clothing has been thoroughly studied in a number of populations and has been shown to reduce the rate of tick attachment and tick bites in studies of volunteers,⁴³ military personnel,⁴⁴ and forestry workers.^{45,46} However, head-to-head studies comparing permethrin to DEET or other repellents suffer from heterogeneous methodologies.^{47,48} Overall, permethrin and DEET appear to be comparatively efficacious; the consumer must choose based on cost, relative risk of toxicity, and the timing of their potential exposure. When used in combination, permethrin-treated clothing and topical DEET were found to be more effective in preventing mosquito bites compared to either used alone.⁴⁹ Although not specifically studied for tick bite prevention, it stands to reason that the combination of permethrin-treated clothing and topical DEET (or picaridin) may be synergistic to reduce the risk of TBI.

Recommendation. Permethrin-treated clothing is an effective tick repellent. Recommendation grade: 1A.

Recommendation. Permethrin-treated clothing, when used in combination with a skin-based tick repellent such as DEET or picaridin, may further reduce the risk of TBI. Recommendation grade: 1C.

Other Repellents

Several essential oils, citriodiol (oil of eucalyptus), and IR3535 are also commercially available as tick repellents.⁵⁰ Others, such as nootkatone, are in development. A review of every available tick repellent is beyond the scope of this CPG. However, each of the aforementioned repellents shares a common trait of either lower repellent efficacy or a significantly shorter duration of action when compared to DEET.⁵¹ Ideally a natural, effective, and nontoxic tick repellent will be available in the future; unfortunately, such a product is not currently available.

Recommendation. Essential oils, citriodiol, nootkatone, and IR3535 have either a lower repellent efficacy or significantly shorter duration of action. Given these

attributes, wilderness recreationalists should avoid these products as first-line tick repellents. Recommendation grade: 2B.

TICK CHECKS

Another highly recommended method of personal protection against tick bites is tick checks. The tick check procedure is as follows⁵²:

1. Remove clothing for overall visual inspection.
2. Systematically scan the body for ticks, paying special attention to warm places (armpits, knees, under underwear, around hairline of neck, ears, and navel).
3. Remove any identified ticks by grasping at the head of the tick with pointed tweezers or tick remover and pulling perpendicular to the skin (Figure 5).

The data supporting this behavior, however, are scant, and its efficacy has not been rigorously studied. In a study of various personal protective methods in definite, possible, and unlikely Lyme disease patients, no difference in tick check performance was found between patients with Lyme disease and controls, suggesting that inspection is not an effective strategy in preventing Lyme disease.⁵³ On the other hand, EM-free control subjects were found to be more likely to perform tick checks within 36 h and bathe within 2 h of being outdoors than those with EM, suggesting a protective effect of these behaviors.⁵⁴

Recommendation. Evidence supporting tick checks is contradictory; however, when combined with bathing within 2 h of being outdoors, these measures may help prevent TBI. Recommendation grade: 1C.

Recommendation. Shower or bathe within 2 h of returning from tick habitat. Recommendation grade: 2C.

CLOTHING CARE

In an early study of *A. americanum* and *I. scapularis* survival after exposure to automatic washer and dryer conditions, all nymphs were killed after 1 h of drying at 40 to 42°C.⁵⁵ Although large proportions of nymphs survived hot water washes in this study, a more recent study showed 100% effectiveness of hot water washes at temperatures greater than 54°C (130°F) in killing both nymphal and adult *I. scapularis*.⁵⁶ These studies did not look specifically at the effect of these interventions on the incidence of TBI, however.

Recommendation. Washing clothes at temperatures over 54°C/130°F and drying clothing in high heat for 10 min kills ticks and therefore may reduce the risk of TBIs. Recommendation grade: 1C.