Preventing mosquito and tick bites: A Canadian update

Heather Onyett; Canadian Paediatric Society, Infectious Diseases and Immunization Committee
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Abstract
The present practice point provides updated guidance on personal protective measures to safely and effectively prevent mosquito and tick bites in Canada. Means of avoidance as well as physical and chemical barriers are described. Current information regarding insect and tick repellents and recommendations for their use are provided, along with instructions for removing ticks. Guidance on using insecticide for additional chemical protection is offered.

Key Words: DEET; Icaridin; Lyme disease; Permethrin; Picaridin; West Nile virus

Mosquitoes and ticks can transmit several infectious diseases to humans. In Canada, two potentially serious – but preventable – diseases acquired from biting arthropods are West Nile virus (transmitted by mosquitoes) and Lyme disease (transmitted by ticks).

Primary care providers may hear more questions from parents about the risks of Lyme disease as the range of the infected tick species expands. The present practice point provides basic guidance on personal protective measures to safely and effectively prevent mosquito and tick bites in Canada. Precautions include avoiding exposure to biting insects, along with using physical and chemical barriers.

Avoidance
Families can reduce exposure to insects and ticks at times when they are most active and in places they are known to thrive. For example, mosquitoes are most active between dusk and dawn, shelter in shady places during the day and breed in standing water.

Ticks breed in or near woodland areas, live in tall grasses and bite more during the spring and fall.[1]

Physical Barriers
Ask families that you see in practice about the physical precautions they take against biting insects and ticks, and advise on some basics as needed.[1][2]

- Use screens on windows and doors at home and while camping, and keep them in good repair.
- If biting insects are present, cover a child’s crib, playpen or stroller with a fine mesh netting.
- If biting insects and/or ticks are present, dress your child in long, loose-fitting clothes that cover the arms and legs, a hat and closed shoes (not sandals). Tucking shirts into pants and pants into socks are extra precautions.
• Light-coloured clothes make it easier to see and remove ticks before they bite, and do not attract mosquitoes as much as dark clothing.

• When residing in or visiting a tick habitat, inspect yourself and your children thoroughly at least daily: include the head, neck and behind the ears. [1][2] If a tick is found, remove it as soon as possible. Ticks can stay attached to skin, feeding on blood and growing larger, for five or more days. However, removing a tick within 24 h to 48 h of starting to feed is likely to prevent Lyme disease because the bacteria will not yet have been transmitted from the tick to the individual.[3]
  - Use fine-tipped tweezers to grasp the tick close to the skin surface (Figure 1A).
  - Pull upward with steady, even pressure (Figure 1B). Try not to twist or jerk, which can cause the mouthpart of the tick to break off and remain in the skin. If this happens and you are unable to remove the mouthpart easily with clean tweezers, leave it alone and let the skin heal.
  - Clean the bite area and your hands with rubbing alcohol, an iodine scrub or soap and water.[3]

Put the tick in a clean container, and contact your local public health unit. Only certain species (in Canada, the black-legged tick) carry the infective agent of Lyme disease (Borrelia burgdorferi). While B burgdorferi is spreading geographically in Canada, not all black-legged ticks carry it. As B burgdorferi spreads to more ticks, it is increasingly important that ticks be identified and tested. Because the capacity to do this varies across Canada, contact your local public health unit for guidance.

Repellents and Insecticides

Repellents help to prevent blood-feeding insects from landing and biting. They do not work against stinging insects such as bees, hornets, wasps and ants. Insecticides kill insects and ticks on contact or soon thereafter. Health Canada’s Pest Management Regulatory Agency (PMRA) reviews the active ingredients in repellents and insecticides for safety and efficacy before they can be sold in Canada. Approved Health Canada products have a Pest Control Product registration number on the product label.[1][4]

Repellents

There are only five registered ‘active ingredients’ in the many different repellents available in Canada (including creams, lotions, gels, solutions, pump sprays and aerosols).[1] The active ingredient in most products is a chemical known as DEET (N,N-diethyl-meta-toluamide), while other chemical repellents are icaridin (hydroxyethyl isobutyl piperidine carbonate, also known as picaridin) and biopesticides, which are derivatives of natural materials. The main biopesticides are oil of lemon eucalyptus and its synthetic equivalent, p-menthan-3,8-diol (PMD).[5] 2% soybean oil and citronella oil.

Recommendations concerning the use of repellents differ in Canada and the United States.[1] Health Canada has not evaluated the safety of repellents for infants <6 months of age, because the PMRA assumes that nonchemical measures should be used to protect this population from bites.

DEET-containing repellents prevent both mosquito and tick bites. Health Canada recommends using a product containing no more than 10% DEET for children ≤12 years of age.[1] However, products with a DEET concentration of ≤10% should not be used for exposures lasting longer than 1 h to 2 h because they may not be effective in preventing tick bites (Table 1).[1][2] For children >12 years of age and adults, a repellent containing up to 30% DEET can be used as recommended on the product label. In the United States, 30% DEET is approved for children ≥2 months of age.[2][6] Reapplication of DEET is indicated only if the estimated protection period has passed and a significant risk of arthropod bites remains.

![Figure 1](image1.png)  How to remove a tick. Reproduced with permission from the United States Centers for Disease Control and Prevention (Atlanta, USA)
Table 1
Estimated protection time against mosquitoes for DEET

<table>
<thead>
<tr>
<th>DEET concentration, %</th>
<th>Protection time, h</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>3.5</td>
</tr>
<tr>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>20</td>
<td>5.5</td>
</tr>
<tr>
<td>30</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Adapted from Health Canada PMRA RRD 2002-01, extracted by reference 8

Adverse events from DEET are rare. Contact dermatitis and eye irritation are the most common side effects. Toxic encephalopathy has been reported, usually with prolonged or excessive use, or occasional DEET ingestion.\(^7\)

Although there is no evidence that DEET-free repellents are safer, many parents prefer them. Icaridin/picaridin has levels of efficacy similar to DEET in preventing mosquito and tick bites. Although it is widely used in Europe and in the United States, this repellent was only licensed in Canada in 2012.\(^8\)

Icaridin is considered to be the repellent of first choice by the Public Health Agency of Canada’s Canadian Advisory Committee on Tropical Medicine and Travel for travellers six months to 12 years of age. Products containing up to 20% icaridin\(^9\) are considered to be safe and efficacious. However, in 2013, only Avon products (Avon Products Inc, USA) containing icaridin were readily available in Canada (Table 2).

Table 2
Comparative efficacy of insect/tick repellents

<table>
<thead>
<tr>
<th>Active ingredient, % concentration</th>
<th>Product name</th>
<th>Protects against</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mosquitoes</td>
</tr>
<tr>
<td><strong>DEET</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5% to 10%</td>
<td>OFF! Skintastic Kids†</td>
<td>2 h</td>
</tr>
<tr>
<td></td>
<td>OFF! Active Lotion†</td>
<td>2 h to 3 h</td>
</tr>
<tr>
<td>25%</td>
<td>OFF! Deep Woods Pump Spray†; Muskol Aerosol‡</td>
<td>5 h to 6 h</td>
</tr>
<tr>
<td><strong>Icaridin</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>Avon Skin-So-Soft (SSS) Bug Guard Plus Icaridin Insect Repellent Spray (aerosol or pump spray)§; OFF! Deep Woods Pump Spray Insect Repellent Clean Feel†</td>
<td>5 h</td>
</tr>
<tr>
<td>20%</td>
<td>OFF! Family Care Clean Feel Insect Repellent Towelettes †</td>
<td>7 h</td>
</tr>
<tr>
<td>Lemon eucalyptus oil 10%</td>
<td>OFF! Family Care Botanicals Lotion†</td>
<td>2 h</td>
</tr>
<tr>
<td>Soybean oil 2%</td>
<td>Bite Blocker¶</td>
<td>1 h to 4 h</td>
</tr>
</tbody>
</table>

Data adapted from references 1,4,5,8,9. *The efficacy of 5% to 10% DEET against ticks is not certain; †SC Johnson & Son Inc, USA; ‡Schering-Plough Canada Inc, Canada; §Avon Products Inc, USA; ¶HOMS LLC, USA; **These products have a duration of action for ticks that is comparable with that of approximately 10% DEET. Additional studies are needed to determine their efficacy against ticks.\(^17\)

‘Natural’ Repellents or Biopesticides

‘Natural’ repellents are not necessarily safer than
DEET or icaridin. People who are sensitive to plant oils may develop dermatitis or eye irritation. Repellents that contain PMD should be considered the next choice after icardin or DEET. Soybean- and citronella oil-based repellents may not protect against tick bites. [10]

In Canada, the topical products containing oil of lemon eucalyptus or its synthetic derivative PMD currently have concentrations no higher than 10%, which provides up to 2 h of protection against mosquitoes (and up to 5 h of protection against black flies). [1] These products can be applied twice daily. However, the PMRA restricts use of PMD-containing repellents to individuals ≥3 years of age. [1] Products with higher concentrations of active ingredient are available in the United States. [11]

Products containing 2% soybean oil provide protection for 3.5 h against mosquitoes (and up to 8 h against black flies). There are no age restrictions or limitations on frequency of use. [1]

PMRA-approved citronella oil products protect against mosquito bites for an estimated 30 min to 2 h. PMRA states that these products should not be used on infants or toddlers. [1]

How to Use Repellents

As with any chemical, make sure to use repellents safely and read the entire label before applying.

- Avoid products with a combination of repellent and sunscreen. Sunscreen typically needs to be reapplied more often than repellent. If repellent and sun screen are both required, apply the sunscreen first, allow to penetrate for 20 min, then apply repellent. [12]
- Apply the product lightly, just enough repellent to cover clothing and exposed skin. [1] [13]
- Avoid applying repellent to a child’s hands so that they are less likely to get repellent in their mouth or eyes.
- Do not apply aerosol or pump products directly to the face, and avoid contact with the eyes and mouth. If spray does get in a child’s eyes, rinse them well with water right away. For children <10 years of age, it is recommended that the child have their eyes closed and hold their breath while an adult sprays. Do not apply repellent on cut, wounded, irritated or sunburned skin.
- Do not apply repellent under clothing.
- Do not apply repellent to clothing or mosquito netting that a child may suck or chew on.
- If mosquitoes are biting, remove the child from the area or reapply repellent if sufficient time has passed.
- Once indoors for the day, the repellent should be washed off with soap and water.
- Spray repellents in open, ventilated areas (not in a tent), well away from food.
- Keep and store repellent safely out of the reach of children. [1] [13]

If a child experiences a local reaction to insect repellent (eg, hives or rash) or a general reaction (eg, facial swelling or breathing issues), wash the repellent off with soap and water. The child requires medical assessment. Parents should be asked to bring the container with them.

Insecticides

Permethrin, a synthetic pyrethroid, is highly effective both as an insecticide and as a repellent. It is not licensed to be used as a topical repellent but can be sprayed on clothing (mesh jackets, hats, shoes) bed nets and camping gear to repel and kill ticks, mosquitoes and other insects. Permethrin may retain its effect for up to two weeks or six washings. [8] While permethrin is considered to be safe for most mammals, the cat appears to be susceptible to it for reasons not fully understood. [14]

Although outdoor clothing, pretreated with permethrin, is approved only for the military in Canada, it is available from major United States online retailers for use by Canadian consumers. [6]

Wearing protective clothing treated with the insecticide permethrin in addition to using DEET or icardin on exposed skin as a repellent may offer the most effective protection overall against mosquito and tick bites. [15] [16]

Many products marketed as protective are not recommended because there is insufficient scientific evidence to support their claims of efficacy and/or safety. Such products include electronic (ultrasonic) devices, electrocuting devices, the citrosa houseplant (a geranium), vitamin B1, and skin moisturizer/insect repellent combinations. [1]
Acknowledgements
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References

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