

Insect Precautions

Why worry?

What works?

Anne E McCarthy, MD, FRCPC, DTM&H, FASTMH, FISTM
 Director Tropical Medicine and International Health Clinic Ottawa Hospital
 Professor of Medicine, University of Ottawa
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Vector types and diseases

- **Mosquito**
 - Dengue
 - Chikungunya
 - Encephalitis, Japanese
 - Filariasis, bancroftian
 - Malaria
 - Rift Valley fever
 - West Nile virus
 - Yellow fever
 - Zika
- **Tick**
 - Encephalitis, tick-borne
 - Lyme, Anaplasma, Babesia
 - Rickettsiosis (also fleas, lice, mites for some species)
 - Crimean Congo hemorrhagic fever
 - Kyasanur Forest dis, Omsk hemorrhagic fever
- **Bug**
 - American trypanosomiasis
- **Flea (rodent)**
 - Plague
- **Fly**
 - Loa loa
 - Onchocerciasis
 - Leishmaniasis
 - African trypanosomiasis

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PRESENTER DISCLOSURE

Relationships with commercial interests:
 - Advisor: Shoreland Inc.

BIG THANK YOU TO LIN CHEN

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Choose the appropriate vector and disease association:

- A. *Aedes* mosquitoes and malaria
- B. *Phlebotomus* sandflies and leishmaniasis
- C. *Triatoma* bugs and African trypanosomiasis
- D. *Anopheles* mosquitoes and yellow fever

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Objective

- Review of vector prevention:
 - Repellents, permethrin, netting
- Provide an overview of vectors (describe vectors and transmission)



Photograph by Paul Dornville

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- D. *Anopheles* mosquitoes and yellow fever

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When is the use of repellent most effective to prevent mosquito bites that transmit malaria?

- A. Mid-day and early afternoon
- B. Early morning and late afternoon
- C. From dusk to dawn
- D. From dawn to dusk

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***Aedes aegypti* are container breeding, adults are indoor dwelling
Peak biting - daytime**

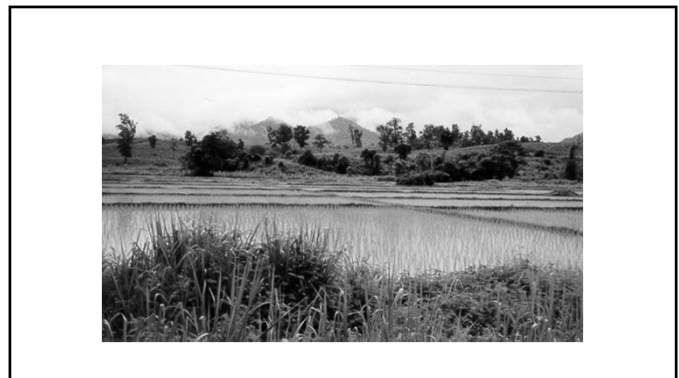
www.cdc.gov/Dengue/entomologyEcology/m_habitats.html

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***Aedes* mosquitoes: dengue, chikungunya, YF, Zika**

Aedes aegypti *Aedes albopictus*

www.cdc.gov/dengue/entomologyEcology/index.html

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***Culex* mosquitoes: JE and West Nile virus**

West Nile virus

Japanese encephalitis virus

Photo: Ames Gathany at phil.cdc.gov/phil/details.asp

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***Culex* mosquitoes: vector of Japanese encephalitis**

- Mosquitoes are infected by feeding on domestic pigs and wild birds, in whom the virus is amplified
- Biting behavior: dusk to dawn
- Often outdoors, but sometimes indoors
- Increased risk:
 - Rural areas, outdoors
 - Long-term travel



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A traveler plans to volunteer in a village in Cambodia. Which vector-disease pair is a significant risk?

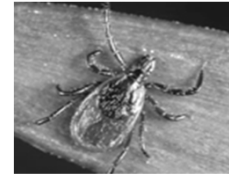
- A. *Ixodes* ticks and tick-borne encephalitis
- B. *Aedes* mosquitoes and Lyme disease
- C. *Culex* mosquitoes and Japanese encephalitis
- D. *Rhipicephalus* ticks and chikungunya

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Ticks



Ixodes scapularis: Lyme, Babesia, Anaplasma

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Ticks

▪ Life: egg 6-leg larva 8-leg nymph adult

- Diseases:
 - Encephalitis, tick-borne
 - Lyme, anaplasmosis, babesiosis
 - Rickettsiosis (esp. ATBF; some can be transmitted by fleas, lice, mites)
 - Crimean Congo hemorrhagic fever
 - Kyasanur Forest disease, Omsk hemorrhagic fever



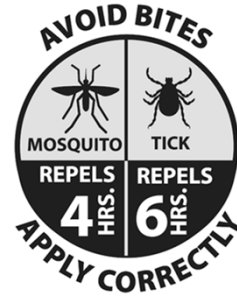
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Bug: American trypanosomiasis



- Protozoan: *Trypanosoma cruzi*
- Vector: *Triatoma* (reduvid bugs, kissing bugs)
- Other transmission modes: transfusion, vertical transmission

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Sandflies: leishmaniasis



- Protozoan: *Leishmania* species
- Vector: sand flies, *Phlebotomus* and *Lutzomyia*

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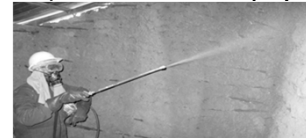
ITNs (insecticide-treated nets)



Coils



Indoor residual spraying



Outdoor spraying



Sources: USAID, Roll Back Malaria, WHO Global Brief on VBD

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Summary: vectors and travel

- **Mosquitoes**
 - *Anopheles*
 - *Aedes*
 - *Culex*
- **Sand flies**
 - *Lutzomyia*
 - *Phlebotomus*
- **Black flies**
 - *Simulium*
- **Horse flies/deer flies**
 - *Chrysops*
- **Tsetse flies**
 - *Glossina*
- **Kissing bugs**
 - *Triatoma*
- **Ticks**
 - *Ixodes*
 - *Amblyomma*
 - *Rhipicephalus*
- **Others:**
 - Fleas
 - Lice
 - Mites

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Mosquito proofing is effective

Location Date	Intervention	Risk ratio after intervention (baseline=1)
Lahore, India 1925-27	British infantry barracks: wire netting, double doors	0.08
Honduras 1926	Local houses: mosquito proofing	0.23
Mining communities, northern Zambia 1930-49	Drainage of flooded areas, modification of river boundaries, vegetation management	0.35

Keiser, Lancet Infect Dis 2005

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Evidence to support methods

- Improve housing design reduced malaria:
 - Modern houses had 47% lower odds of malaria infection/ 45-65% lower odds of clinical malaria
- Insecticide-treated nets/curtains/screen: 77% protective efficacy vs. cutaneous leishmaniasis
 - High protective efficacy of:
 - ITS vs. dengue
 - ITNs vs. Japanese encephalitis
- Larval source management reduced malaria incidence by ¼:
 - 2 cluster-RCTs (Sri Lanka): larviciding abandoned mines, streams, irrigation ditches, rice paddies.
 - 1 trial (India): removal of domestic water containers + weekly larviciding of canals/ stagnant pools.

Tusting et al. Malaria J 2015; Wilson et al. PNTD 2014; Tusting et al. Cochrane 2013

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Repellents

Product	Active ingredient	Complete protection time (mean, minutes)
Deep Woods Off	DEET 23.8%	301.5
Bite Blocker for Kids	Soybean oil 2%	94.6
Skin So Soft Bug Guard Plus	IR3535 7.5%	22.9
Natrapel	Citronella 10%	19.7
Repello Wristband	DEET 9.5%	0.2

Fradin, Day. N Engl J Med 2002

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Insecticide: permethrin, deltamethrin, cypermethrin

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Consumer Reports 2018: www.consumerreports.org/products/insect-repellent/ratings-overview/

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Repellents: EPA approved

Active ingredient	Chemical name	Brands
DEET	<i>N,N</i> -diethyl- <i>m</i> -toluamide or <i>N,N</i> -diethyl-3-methyl-benzamide	Off! Cutter Sawyer Ultrathon
Picaridin	2-(2-hydroxyethyl)-1-piperidinecarboxylic acid 1-methylpropyl ester; KBR 3023, Bayrepel, icaridin	Cutter Advanced Skin So Soft Bug Guard Plus Autan
Oil of lemon eucalyptus*	<i>para</i> -menthane-3,8-diol; PMD	Repel
IR3535*	3-[<i>N</i> -butyl- <i>N</i> -acetyl]-aminopropionic acid, ethyl ester	Skin so Soft Bug Guard Plus Expedition
2-undecanone	methyl nonyl ketone	BioUD

*Biopesticides

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Frequently asked questions

Question	Answer	Evidence
Is DEET safe in children?	Yes; 2 months and older; adults to apply	CDC, AAP
Is DEET safe in pregnancy?	Yes; trimesters 2-3 use on Thai-Myanmar border found no adverse effects on survival, growth, development at birth and 1 year	McGready et al. AJTMH 2001.
Is controlled-release DEET more effective?	Possibly; polymer formulation touted to last longer	Rutledge et al. J Am Mosq Control Assn 1996.
In what order should one apply DEET and sun screen?	Sun screen 1 st , then DEET. Limited data suggest reduction of DEET mean protection time when sun screen applied on top	Webb et al. Aust N Z J Public Health 2009.
Is permethrin safe to use during pregnancy?	Very limited data; no significant, consistent association identified.	

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Repellents and children

	DEET	Picaridin (KBR 3023)	p-Methane diol (PMD= oil of lemon eucalyptus)	IR3535
CDC	>2 mo, up to 50%	>2 mo 7%, 15%	>3 yrs (EPA)	>2 mo
AAP	>2 mo, up to 30%	-	-	-

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What does not work?

Garlic	Rajan et al. Med Vet Entomol 2005
Vitamin B	Ives et al. J Am Mosq Control Assoc 2005
Ultrasound	Sylla et al. Wien Klin Wochenschr 2000

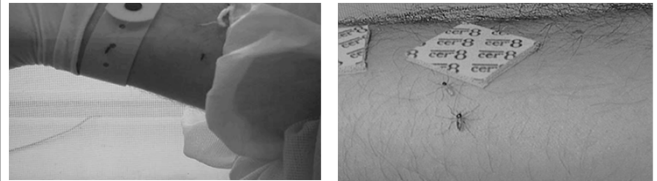
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The following is a safe and effective measure to prevent malaria:

- A. Taking garlic extract
- B. Applying picaridin repellent to skin
- C. Spraying skin with permethrin
- D. Consuming 1 liter of tonic water every 15 minutes

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Ineffective: repellent-bracelet ...or...tape



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A traveler is going to Dominican Republic x 1 week, stay in a hotel. The key preventive measure against chikungunya virus infection is:

- A. Sleeping under insecticide-treated nets
- B. Administering the newly licensed vaccine
- C. Wearing long sleeves and pants impregnated with p-methane-diol
- D. Applying effective mosquito repellent to exposed skin

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Online resources

- CDC. www.cdc.gov/DiseasesConditions/
- CDC Travelers' Health. www.cdc.gov/travel
- WHO. www.who.int.ith
- CDC Division of Vector-Borne Diseases www.cdc.gov/ncidod/dvbid/westnile/RepellentUpdates.htm
- EPA. <http://epa.gov/pesticides/insect/safe.htm>
- WHO. Global Brief on VBD. www.who.int/campaigns/world-health-day/2014/global-brief/en/
- PAHO. www.paho.org

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New developments

- Coating Bed Nets With Antimalarial Drugs To Zap Parasites In Mosquitoes
- <https://www.mprnews.org/story/2019/02/27/npr-promising-new-bed-net-strategy-to-zap-malaria-parasite-in-mosquitoes>
- GMO mosquitos

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References

- Fradin MS, Day JF. Comparative efficacy of insect repellents against mosquito bites. *N Engl J Med* 2002;347:13-18.
- CDC. Protection against mosquitoes and other arthropods. In: Health Information for International Travel 2016.
- CATMAT. Statement on Personal Protective Measures to Prevent Arthropod Bites. *Canada Communicable Dis Rep* 2012;38. Available at <http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/12vol38/acs-dcc-3/index-eng.php>

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Summary: vector avoidance

- What works:
 - Timing of activities
 - Long sleeves, long pants
 - Mosquito proofing
 - Insecticide-treated nets
 - Insecticide-impregnated clothing
 - Repellents



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Anopheles gambiae.
From CDC image library



Aedes albopictus



Aedes aegypti



Culex

From CDC image library

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