They Want to Suck Your Blood! Mosquito Management Around Schools and Childcare Facilities

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Mosquitoes are insects that are infamous for wanting to suck your blood. Adult female mosquitoes need blood to develop eggs and will feed on a diversity of hosts, including humans. When a mosquito bites, she injects saliva that makes blood-feeding easier. Your immune response to the saliva makes the bite itchy and irritating. More importantly, pathogens can be transmitted with the saliva when the mosquito bites.

In Tennessee, the pathogens of greatest concern are **West Nile virus** (WNV) and **La Crosse virus** (LACV) (Figure 1). Most people (80 percent) infected with WNV will have no symptoms; however, about 20 percent will experience fever, chills, nausea and joint pain, and less than 1 percent will develop a serious neurological illness. Those infected with LACV are normally children under the age of 16; adults are generally asymptomatic. In severe cases, infection with LACV will progress to a serious neuroinvasive disease resulting in recurrent seizures, coma, brain swelling, paralysis, and cognitive and neurobehavioral abnormalities. A majority of West Nile encephalitis cases are reported in western

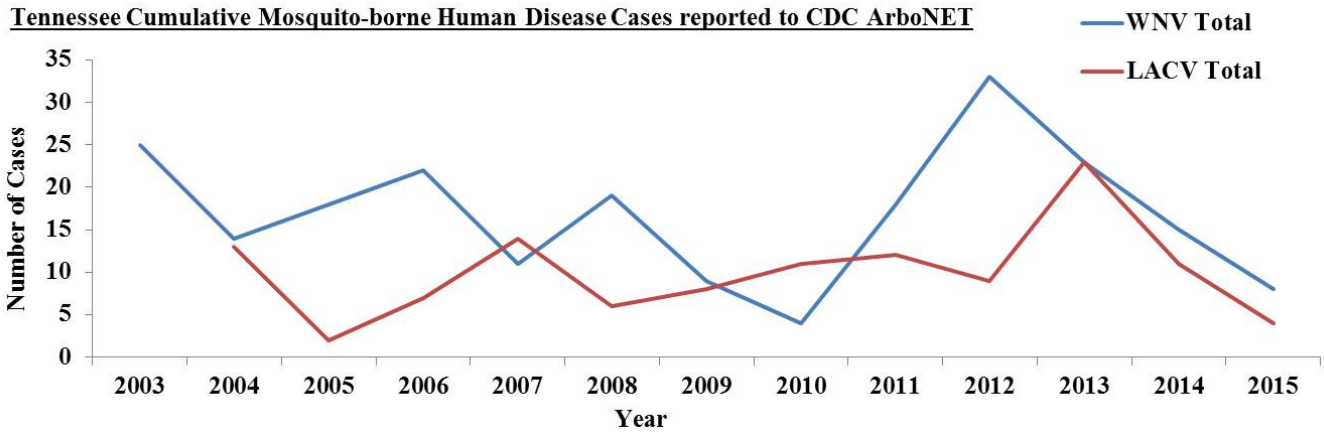

Figure 1. On average, 26 Tennessee citizens are diagnosed with a mosquito-borne disease every year. Source: diseasemaps.usgs.gov

and central Tennessee in August and September, while La Crosse encephalitis is reported in eastern Tennessee from June through August.

While several foreign mosquito-borne viruses pose a public health risk in Tennessee (including Zika, Dengue and Chikungunya), the risk of these viruses establishing in local mosquito populations in the state is low given the absence of the primary mosquito vector *Aedes aegypti*. More often, these viruses are a problem for travelers; however, the Asian tiger mosquito (*Aedes albopictus*) is common in Tennessee and it could play a role in transmission of these viruses to humans. Fortunately, the Tennessee Department of Health and its partners monitor for these potential threats with active mosquito and case surveillance and would take action to protect the public if needed.

In the U.S., WNV and LACV are the most common cause of arboviral (insect–transmitted) encephalitis in children. There are no vaccines to prevent infection from either virus or specific antiviral treatments to manage disease other than supportive care. Prevention of mosquito bites is therefore critical in protecting the health and safety of children. This document discusses methods to reduce mosquito populations and mosquito bites around schools to help create a safer and healthier learning environment where students can succeed.

Mosquito Management

The best strategy for controlling mosquitoes and protecting human health is by using **Integrated Pest Management** (IPM). IPM incorporates several control tactics to manage mosquito populations, thereby reducing bites that may result in disease. The IPM plan will include the use of insecticides, which are used only as needed based on prescribed treatment thresholds. The IPM Action Plan for Mosquitoes (articles.extension.org/pages/20999/ipm-action-plan-for-mosquitoes) provides these suggested thresholds. Lowering the frequency of pesticide application makes IPM **cost effective** and reduces pesticide exposure for students, faculty, staff and the environment.

IPM is made of five primary components:

- Identification of pests through surveillance efforts, with a risk assessment of pest species based on an understanding of pest biology.
- Development of methods to monitor pest populations.
- Determination of pest management objectives and thresholds for control measures.
- Implementation of control measures, with insecticide used based on defined treatment thresholds.
- Continuation of monitoring of pest populations to determine if control measures were successful and if management objectives are being met.

Collaboration with parents, students, faculty, professional pest control companies, maintenance staff and others is needed to execute the steps in IPM and achieve effective mosquito control. **Education** is one of the most powerful tools in IPM, so consider having a meeting with all parties involved in the IPM plan to educate them on mosquitoes and mosquito-borne illnesses, discuss how some behaviors put them at risk for mosquito bites, and how they can protect themselves. School administration should consider adopting an IPM policy. This would serve as an outline for the IPM strategy and demonstrate a commitment to creating a safe environment for students. Information within the policy would include roles and responsibilities of collaborators, pest monitoring tactics, pest thresholds, parties allowed to apply pesticides, etc. More information on IPM policies, including a model policy, can be found at epa.gov/managing-pests-schools or schoolipm.utk.edu/success_results.html.

Figure 2. Examples of mosquito development sites. Water in a tire, debris-filled gutters, ground depressions due to broken downspout and misaligned splash block, and children's toys. (Photos: R. Trout Fryxell and K. Vail)

Mosquito Life Cycle

The mosquito development cycle follows a pattern known as complete metamorphosis, with an **egg**, **larval**, **pupal** and **adult** stage. All of the immature stages (eggs, larvae and pupae) are **aquatic**. After an adult female mosquito has taken a blood meal, she will search for water sources to lay her eggs (**standing water, including containers** [Figure 2]).

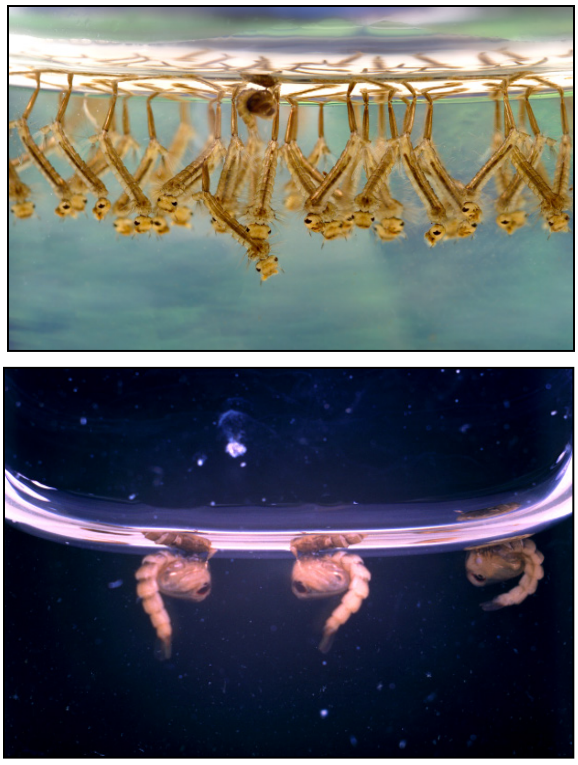

Figure 3. Larvae of the southern house mosquito* Culex quinquefasciatus*, a common vector of WNV (top). The characteristic swimming pattern gives the larval common name of wrigglers.* (Photo: James Gathany, CDC) *Pupae (bottom) of the yellow fever mosquito* Aedes aegypti *which can transmit ZIKA, DENV and CHIKV. Pupae are comma-shaped and will tumble when disturbed, giving them the common name tumblers. (Photo: Dr. Pratt, CDC)

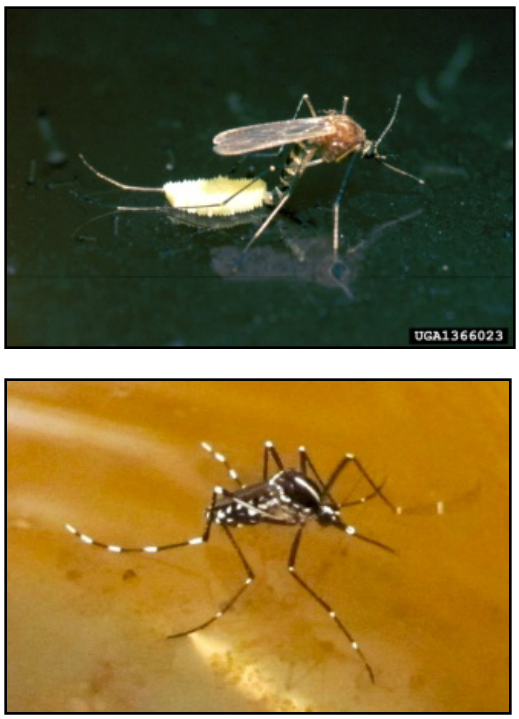

Figure 4. The northern house mosquito* (Culex pipiens) *transmits WNV (top). (Photo: S. Ellis, Bugwood.org) The Asian tiger mosquito (*Aedes albopictus*) transmits LACV (bottom). (Photo: C. Urquhart)

The eggs will hatch into larvae (wrigglers), which develop into pupae (tumblers) (Figure 3). Finally, the adult mosquito emerges from the pupa ready for her first meal (Figure 4). Only female mosquitoes bite, most commonly during early morning and late evening, although some species are more prone to bite during the day in shaded areas.

Understanding that immature mosquitoes need water is important for identifying and eliminating water sources using cultural control. Information on the time when the target mosquito species is actively biting will be critical if adult control measures are necessary. In addition to cultural control, other commonly used control tactics include mechanical and chemical. Before implementing these strategies, work with the public health department or a private pest control company to identify and monitor mosquito populations around the premises to develop effective control measures.

Control

Cultural Control

This control technique can be thought of as **making the environment unfavorable** for mosquitoes. This includes disrupting immature mosquito development by identifying sites where mosquitoes lay eggs and then removing or modifying those sites. This is the best means of controlling mosquito bites since it prevents mosquitoes from becoming adults, which can happen in only seven days during the warm summer months in Tennessee. Here are a few tips for identifying and controlling mosquito development sites and making the environment unfavorable for mosquitoes.

- Anything that can hold water can act as a development site for mosquitoes, including swings, tires, buckets, toys, playground equipment, trash (e.g., cans, bottles, bottle caps, or cups on the ground after a sporting event), etc. (Figure 2). These sources should either be removed or water from these sources should be drained immediately and/or have holes drilled into the bottom to promote drainage.
- Items that are meant to hold water, such as fountains, birdbaths, flowerpots and plant saucers, should have the water inspected and changed every week to ensure that immature mosquitoes do not become adults. Containers too large to remove or tip

over such as trash and recycling receptacles can be covered.

- Tree holes and stumps can be excellent development sites for mosquitoes. Recommended arboricultural practices include covering holes with an aluminum or stainless steel exclusion plate or filling holes with waterproof expanding foam (not concrete) to prevent water buildup.
- Adult mosquitoes will often rest on vegetation during the day. Work with facilities maintenance staff to schedule regular lawn mowing and removal of weeds and dense vegetation from the premises to reduce suitable resting sites for mosquitoes.
- Work with maintenance staff to regularly check gutters, rooftops (especially flat-roofed buildings), and downspouts that can hold water if not properly maintained (Figure 2). Ensure proper drainage of water from downspouts and other sources, as mosquitoes can develop in puddles of water and in corrugated drainage pipes.
- If possible, **reduce outdoor activity during dawn/dusk** when mosquito activity is high.

Mechanical Control

This control technique involves creating **physical barriers to prevent adult mosquitoes from getting to a person**. Follow these steps to keep mosquitoes away.

- All window and door screens should be free of tears and holes. Repair and/or replace screens if damaged.
- Consider erecting a fence that prevents students from playing in shaded forested areas near the school where day active mosquitoes, like Asian tiger mosquitoes, are likely to bite.
- Suggest that students dress in protective, light-colored clothing including long-sleeved shirts, pants and closed-toed shoes that can prevent mosquitoes from biting.

Chemical Control

The school IPM policy should clearly state who is allowed to make pesticide applications. Most means of controlling larval and adult mosquitoes with chemicals should be carried out by **pest control professionals** certified to apply insecticides. This party would maintain a pesticide applicator's license and apply products in a manner consistent with their label and in accordance with local, state and federal guidelines. Private and public spaces require different pesticide certifications and licenses. Contact your local county Extension office, the University of Tennessee Pesticide Safety Education Program, or the Tennessee Department of Agriculture inspector to determine certifications and licenses needed for servicing your property.

Outdoor ultra-low volume sprays are the most common means of controlling adult mosquito populations when either nuisance thresholds have been surpassed or virus activity has been detected. Sprays are typically done during peak biting activity, near dawn and dusk. If control of adult mosquitoes is necessary, students, parents, faculty and staff should be notified in

advance of insecticide application. It is important to keep contact with the responsible party to ensure spraying is done after school hours and when weather permits.

Some over-the-counter products can be used for killing immature mosquitoes. These products commonly use spores and toxins from the bacteria *Bacillus thuringiensis israelensis,* which is highly specific to mosquito larvae and should not harm other animals including humans. Remember to **always follow the instructions on the label** when using any product.

Personal Protection With Repellents

Repellents are a form of chemical control that can, and should, be used to help protect students, faculty and staff. Some products marketed as repellents **have not been shown to be effective at repelling mosquitoes.** These ineffective products may include sound emitting devices, bracelets, bug patches and bug zappers. Additionally, there are no foods that can be eaten that will repel mosquitoes.

The Environmental Protection Agency (EPA) has approved several active ingredients that can effectively prevent mosquito bites. These include DEET, IR3535, Picaridin, 2-undecanone, and some Oil of Lemon Eucalyptus (OLE) and PMD products. Product effectiveness and longevity will vary depending on the concentration used. Products containing OLE should not be used on children under the age of 3.

For a complete list of repellents that prevent mosquito bites, you can visit the EPA website and find the repellent that is best for students, faculty and staff (epa.gov/insect-repellents/find-insect-repellent-right-you).

Additional Considerations for Repellents

- When choosing the best repellent, it is important to consider the length of time spent outdoors, location, and risk to pathogens; for example, dinner and movie in a park near previous WNV activity.
- Parents should apply repellent to their child.
- Make sure to **apply sunscreen** before applying repellents.
- Do not use products that combine sunscreen and repellent because sunscreen needs to be reapplied more frequently. Additional repellents could be kept in the school nurse's office if reapplication is necessary.
- Most importantly, **always follow the instructions on the label**. This will prevent any negative effects due to exposure. If a rash or other irritation occurs, wash the repellent off with soap and water and contact a local poison control center.

Conclusions

Preventing mosquito bites is the best way to protect students, faculty, staff and others in schools from suffering from a mosquito-related illness. These five rules can serve as the basic guidelines for bite prevention:

1. Apply repellents like **DEET.**
2. **Dress** in clothes that prevent mosquitoes from biting.

3. **Dump** standing water sources.
4. Reduce activity at **dawn and dusk.**
5. **Collaborate** and **communicate**!

To learn more about managing pests in schools see the UT Extension Child-serving Facility IPM website at schoolipm.utk.edu.

For more information on how to prevent mosquito bites, visit the Centers for Disease Control website at cdc.gov/features/stopmosquitoes

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