



Toward Safer Mosquito Control in New York

January, 2000

INTRODUCTION

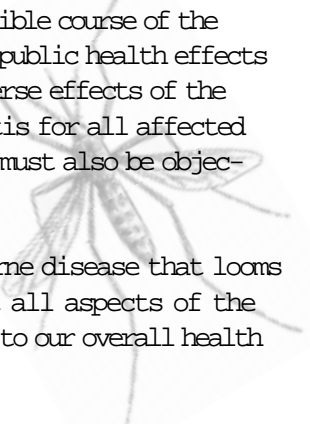
Last fall, the dual crises of West Nile encephalitis and widespread pesticide spraying highlighted significant gaps in the preventative public health infrastructure of many, if not all, of the affected municipalities in the New York City region. During this winter hiatus, while state and county budgets are being negotiated, it is time to step back and fully evaluate the events of the fall in order to plan effectively and avoid repeating them.

There is no foolproof means of preventing infectious disease outbreaks, and their incidence will likely be exacerbated and entail more unfamiliar illnesses as global warming and global travel increase microbe circulation. We will always be at risk. But, when faced with similar hazards, other communities across the country have found that it is possible to keep them in check without the kind of wholesale pesticide exposure spawned by this past fall's outbreak. In Houston, Los Angeles, St. Louis, and other areas where mosquito-borne diseases erupt repeatedly, widespread aerial spraying of pesticides that target adult mosquitoes (known as adulticides) rarely if ever occurs. We have an example of the elements of a comprehensive mosquito control program closer to home in Suffolk County, but if the preventative measures it employs are not fully financed and consistently followed regionwide, everyone remains at risk.

It is essential to implement preventative measures, not only because, ideally, disease outbreaks should be avoided, rather than contained after they have claimed lives, but also because the containment measure - pesticide spraying - entails risks of its own. Furthermore, over-reliance on emergency applications of adulticides, as opposed to preventative public health measures, is one of the factors implicated in the resurgence of other mosquito-borne diseases, such as malaria and dengue fever, in other parts of the world.¹

The New York State Department of Health (DOH) has put forward an overall game plan for addressing a potential disease outbreak in the coming season. Although it contains many necessary elements, it omits several others (outlined below under alternative mosquito control). Nor does it contain any explicit provisions for follow-up analysis of last year's events: the actual and possible course of the epidemic, whether or not aerial spraying influenced that course, and the corollary public health effects of pesticide exposure. With the greater perspective that hindsight allows, the adverse effects of the pesticides used must be fully examined and compared to the risks of the encephalitis for all affected populations. The pesticides' actual efficacy in checking the threatened epidemic must also be objectively evaluated.

West Nile encephalitis is not the only, or even the most dangerous, mosquito-borne disease that looms on the horizon in this region.² But this moment represents an opportunity to look at all aspects of the crisis in order to learn how best to prevent other potential epidemics at least cost to our overall health and the environment.



PESTICIDE RISKS

The pesticides chosen to combat West Nile encephalitis are not neutral agents, but entail their own entirely separate set of risks. The following briefly summarizes the characteristics of the three major pesticides used last fall for mosquito control.

Malathion. Malathion is an organophosphate insecticide that works by interfering with an enzyme, cholinesterase, essential to normal nervous system function in insects and humans alike. Although it is one of the less acutely poisonous of this family of pesticides, exposure to malathion nonetheless entails real toxicity concerns, including respiratory distress, headaches, dizziness, and nausea.³ Like all organophosphates, at high doses it can cause more serious symptoms.⁴ For example, malathion was the second leading cause of hospitalization for occupational pesticide poisoning in the United States during the period 1977-1982.⁵ A recent study of acute adverse effects from aerially applied malathion bait for medfly control in Florida found 123 probable or possible cases tied to the spraying, including respiratory, gastrointestinal, neurological effects, dermatitis, and eye damage.⁶

Infants and children, whose immature nervous systems are vulnerable to insult, and newborns, whose metabolisms are less capable of detoxifying malathion, are more susceptible than adults to its toxic effects.⁷ Organophosphate poisoning in children may also result in a different set of symptoms than adults commonly experience, including increased muscle tension and rigidity.⁸

Information on long-term, chronic effects is less abundant. Currently, malathion has not yet been classified by the United States Environmental Protection Agency (EPA) as to its carcinogenic potential, although a decision on its classification is pending and likely in the early part of 2000.⁹ Over the years, reports in the epidemiological literature have indicated that malathion may compromise the immune system,¹⁰ cause reproductive harm,¹¹ and cause genetic mutations or interfere with normal cell replication.¹² One study of aerially applied malathion for medfly control in California found an association between malathion exposure during the second trimester of pregnancy and the occurrence of gastrointestinal abnormalities in infants.¹³

Being a broad spectrum insecticide, malathion kills other insects as well as mosquitoes, including honeybees, to which it is highly toxic. It is also highly toxic to many aquatic organisms and the aquatic stages of amphibians.¹⁴

Resmethrin and d-phenothrin. Resmethrin and d-phenothrin (also known as Sumithrin®) are synthetic pyrethroid insecticides.¹⁵ Pyrethroids, like organophosphates, affect the nervous system, though they do not inhibit cholinesterase. They are of relatively low acute toxicity, although poisoning can occur and allergic responses have been reported.¹⁶ There are also reports of persistent symptoms when exposures occurred indoors.¹⁷

Like malathion, resmethrin and d-phenothrin have not yet been classified with regard to carcinogenicity, although products that contain these substances often include the synergist piperonyl butoxide (PBO), which has been classified by the EPA as a possible human carcinogen, as have several other pyrethroid insecticides.¹⁸ There are indications that pyrethroids may interfere with the immune¹⁹ and endocrine systems.²⁰ Other adverse chronic effects, including effects on the liver and thyroid, have been reported in toxicology testing of resmethrin.²¹

How these reports of possible chronic health problems of malathion, resmethrin, and d-phenothrin may relate to the dose or frequency of exposure encountered in last fall's spraying campaign is unknown and to date, no cataloguing of adverse effects has been forthcoming from the state or local health departments that would help with such an assessment. It is also impossible to say how they may interact with the other pesticides to which area residents are exposed. Data on such chemical interactions are virtually nonexistent.

BASICS OF ALTERNATIVE MOSQUITO CONTROL

Avoiding the use of pesticides, such as malathion and pyrethroids, that control adult mosquitoes should be item one on the state's disease control agenda. It is a strategy of last resort, when all other control possibilities have been exhausted. In addition to health concerns about pesticides, repeated use of these chemicals breeds resistance and reduces their effectiveness for times when they may be the only option.²²

Effective preventative mosquito control thus relies on a combination of before-the-fact measures, including:

- Removal of breeding habitat by reducing standing water wherever possible.²³ This is less effective with mosquitoes, including some *Culex* species, which breed in confined or inaccessible water sources such as storm drains.
- The use of meteorological data to identify weather patterns known to exacerbate specific vector-borne diseases (such as the prolonged drought conditions followed by heavy rains that the New York City region experienced last summer) and follow up with enhanced monitoring when such conditions exist.²⁴
- Control of mosquito populations when they are in the larval and pupal stages. There are a variety of non-toxic and least toxic methods of larval control, such as applying *Bacillus thuringiensis israelensis* (BTI) bacteria to stagnant waters, using *Bacillus sphaericus* in storm sewers, and stocking isolated water bodies with mosquito-eating fish.²⁵ Certain fungal and zooplankton species that attack mosquito larvae have been examined as potential control measures²⁶ and insect growth regulators are currently in use (though these, by interfering with insect hormonal signals, may pose endocrine system hazards beyond their intended use). Mechanical controls in the larval and pupal stage include use of light vegetable-based oils to smother egg rafts, and (as yet untested) controlled burns.²⁷ Some of these products or techniques have effects on non-target species and thus each use should be evaluated from this perspective.²⁸
- Trapping and monitoring mosquitoes to detect the presence of mosquito-borne illnesses and their levels in the mosquito population. Trapping can also localize those areas of greatest mosquito/disease potential should a targeted response with least-toxic insecticides be deemed necessary, instead of blanket spraying of wide areas. In addition to monitoring, new traps are on the market, using carbon dioxide as a lure, which are designed to control mosquito populations for areas of up to an acre.
- The use of sentinel birds to detect the presence of disease before it reaches humans. For instance, chickens are commonly used bird hosts for monitoring whether St. Louis encephalitis is present in the local bird population. Like trapping and monitoring of mosquitoes, the use of sentinels detects the presence of disease before it reaches human populations and helps pinpoint the areas where it must be controlled.²⁹

The benefits of preventive control and monitoring are myriad. They reduce the likelihood that a surprise outbreak will occur while minimizing the use of hazardous pesticides. Harris County, Texas (Houston), which has one of the most active St. Louis encephalitis programs in the country, has not resorted to aerial spraying for years. Through effective monitoring, its program can identify infected areas a month before any human comes down with the virus, and thereby address potential outbreaks at the source. This approach not only saves human lives, but also reduces pesticide use and saves the county approximately one million dollars each year.³⁰

Examining the 1999 Outbreak and Response

No plans for a new mosquito season can be confidently accepted unless they are based on a full and rigorous assessment of the events of last fall. The following issues should be thoroughly examined by

state and county health departments, and results reported to the public:

The observed adverse effects of spraying. A complete accounting of all adverse effects associated with this crisis, whether from the disease or the spraying, is essential in order to evaluate their relative risks. The Centers for Disease Control's (CDC) recent assessment of human poisoning incidents from malathion spraying for medfly control in Florida provides a precedent for assessing such effects,³¹ as do at least two birth defect studies done in the wake of medfly spraying in California.³² Retrospective surveys of clinic and emergency room admissions, calls to poison control hotlines, private physician records, and birth defects registries can all be used to catalogue and assess the dimension, nature, and severity of adverse reactions for comparison to the toll (actual and potential) from encephalitis. Environmental impacts on non-target insect, bird, and aquatic species must also be assessed.

The potential and actual size and virulence of the West Nile epidemic. The projected possible dimensions of the West Nile outbreak that caused state health authorities to recommend spraying must be fully disclosed. Messages from state and local authorities describing the low relative virulence and likelihood of contracting West Nile disease (apparently in order to quell public panic over the disease) directly conflicted with the dramatic remedy chosen – widespread pesticide spraying. These disparate signals cannot be reconciled without a full accounting of the underlying assumptions of the potential epidemic by state and federal authorities. The size, severity, and relevance of other West Nile epidemics across the globe; mosquito population data and infection rate; local serological studies; and a catalogue of case outcomes, should all be compiled to both describe the assumptions made last fall when deciding on a course of action, and to verify the accuracy of those assumptions in light of what actually transpired.

Spraying efficacy. The state must examine the actual course of the epidemic to determine whether spraying was truly effective in checking it. Data now available indicate that the epidemic peaked in late August, prior to the earliest spraying on September 3.³³ The overall effectiveness of the spraying should thus be assessed, but particularly that spraying which occurred after cold weather had set in and mosquito dormancy begun. Experience with other vector-borne diseases can serve as models for making such judgements. For example, aerial and ground adulticide spraying for control of *Aedes aegypti*, the mosquito species responsible for spreading dengue fever, are widely acknowledged to be ineffective at both controlling the mosquito population and influencing the course of dengue epidemics.³⁴ Though this may be due to features of *Aedes aegypti* natural ecology not shared by all other mosquito species, the fact that spraying programs of long standing were ultimately found futile indicates that pesticide efficacy (not the simple of efficacy of killing exposed mosquitoes but the broader efficacy of controlling populations and curtailing disease) is an open question with each new climate/mosquito/disease combination that arises. All potential disease vectors (other mosquito species besides *Culex pipiens* may have been involved) must be evaluated in this manner.

RECOMMENDATIONS

DOH has released the outline of a "collaborative" campaign with county health departments to tackle a potential West Nile outbreak next spring.³⁵ The plan focuses on breeding site abatement, disease reporting, mosquito and bird/animal surveillance, laboratory capacity and readiness – all essential elements of a successful plan. Missing however are a number of key steps referred to above, most notably biological or least toxic larvaciding, that are hallmarks of successful vector control programs across the country. Breeding site reduction alone cannot accomplish larval population reduction because many of the potential vector species breed in water sources, such as storm drains, sewers, and wetlands, that by their nature cannot be eliminated.

A comprehensive DOH plan, to be implemented in conjunction with the counties, should include all of the following:

Long term mosquito monitoring and preventative control. When spring arrives, a comprehensive mosquito control policy must be in place – one which uses all of the various techniques outlined above and also investigates newer, non-toxic adult mosquito trapping technology for potential effectiveness. Avoiding the use of adulticides should be a priority. Regardless of whether the West Nile virus re-emerges this spring, the state must maintain a constant vigilance for potential mosquito-borne disease outbreaks, including those of a far more serious nature, such as eastern equine encephalitis. Early detection and control is safer for humans and the environment, because it minimizes the use of pesticides and uses animal sentinels, not humans, as a surveillance tool. A preventative approach is far less expensive and more effective than the after-the-fact spraying resorted to last fall.

Coordination among state and local public health officials to improve surveillance, control measures, and emergency response planning. The state should work closely with counties, coordinating and monitoring their varying responses with one another and those of neighboring states, some of which have effective mosquito control programs. The state should develop a regional plan for monitoring and preventing disease outbreaks, and timely information and resource sharing to implement such a plan. A working group of state and local health officials has begun this task. Their meetings should be well-advertised, open, and should provide timely documentation of their plans and conclusions.

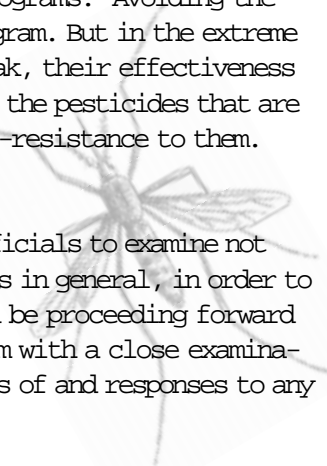
Funding for implementation. The State Legislature should ensure, through the budget process, that adequate funding is provided to the State Department of Health both for its own coordination efforts and for reimbursement to the counties for monitoring and surveillance. To date reimbursement levels to the counties for expensive monitoring, surveillance, and larvaciding activities have not been clarified.

A vector control plan to guide the state in responding to future arboviral disease outbreaks. These response guidelines should include different response recommendations for each potential arbovirus keyed to threshold levels of disease in sentinel birds and mosquitoes, mosquito activity, and human cases. Full-scale aerial spraying response is not the appropriate response to most disease situations and should not constitute the first line of defense when arboviruses are detected. Other states, such as California³⁶ and Massachusetts have tiered systems for responding to different disease potential indicators in sentinel, mosquito, animal, and human populations.

Curtailment of other pesticide use. Both because of their inherent hazards, and the risk of developing resistance and cross-resistance in disease vector species,³⁷ overall pesticide use in New York State should be minimized. Purely aesthetic uses, such as lawn and garden applications, should be eliminated. Other pesticide uses for which ready alternatives exist, such as many interior structural applications, should also be eliminated. The state should phase-out its own use of most pesticides (as communities across the country, including six New York State municipalities, have already begun doing) and should actively support organic farming, through research and procurement programs. Avoiding the use of adulticides should be one of the inherent tenets of a vector control program. But in the extreme event that some applications are necessary to prevent a serious disease outbreak, their effectiveness as a control tool is potentially compromised by the widespread, frivolous use of the pesticides that are the same as or related to the agents of mosquito control, or which confer cross-resistance to them.

CONCLUSION

The events of this past fall should serve as a wake-up call to state and local officials to examine not only disease detection and response readiness, but also pest and pesticide risks in general, in order to devise preventative, less hazardous methods of dealing with them. We should be proceeding forward with alternative means of preventing outbreaks, and we should do so in tandem with a close examination of the actual events of the fall in order to make more educated predictions of and responses to any future disease occurrence.



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