NEW JERSEY'S APPROACH TO ENCEPHALITIS PREVENTION [1]

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ABSTRACT: Since 1975, the state of New Jersey has developed a cooperative program to monitor and control eastern equine encephalitis (EEE) virus. The agencies involved in the program include: the New Jersey Agricultural Experiment Station, the New Jersey State Department of Health, the New Jersey State Department of Agriculture, the New Jersey Department of Environmental Protection, and seven county mosquito control agencies that benefit directly from the service. Funding is provided by the New Jersey State Mosquito Control Commission on an annual basis. The program monitors EEE and its mosquito vectors at a number of established study sites in the state where human or equine cases have caused concern in the past. *Culiseta melanura* is used as the main indicator of virus activity in nature. Deviations in population levels from the long-term mean are calculated by computer and Minimum Field Infection Rates (MFIR) in *Cs. melanura* are updated weekly. All information is made available to state and county mosquito control agencies on a regular basis during the encephalitis season. Equine cases are used as an indicator for accelerated control of *Coquillettidia perturbans* and associated vectors in inland areas of the state. The physiological age of *Aedes sollicitans* populations is used as the main indicator of risk for transmission to humans. During periods of risk, chemical control is directed toward localized, physiologically "old" populations of *Ae. sollicitans*. Since the inception of this program, the number of confirmed human cases of EEE have declined markedly and broad-scale emergency airsprays have not been needed.

INTRODUCTION

In 1975, the New Jersey Agricultural Experiment Station developed the New Jersey Vector Surveillance Program, a monitoring effort directed toward eastern equine encephalitis (EEE) and its mosquito vectors in coastal areas of the state (Crans et al. 1976). Since that time, the program has grown and is now a cooperative effort that involves the New Jersey Department of Health, the New Jersey Department of Agriculture, and the New Jersey Department of Environmental Protection, as well as seven county mosquito control agencies that benefit from the service. The program is funded annually by the New Jersey State Mosquito Control Commission, a commission that is appointed by the Governor of New Jersey to oversee the expenditure of an allotment of state funds to be directed toward responsible mosquito control.

The objectives of the program are two-fold: 1) to determine if EEE virus is present in nature in a variety of established study sites where the disease has been detected in the past, and 2) to determine the risk of transmission to humans. In the event of risk, the New Jersey State Mosquito Control Commission utilizes its State Airspray Program to control the epidemic vectors and minimize the potential for transmission to humans.

New Jersey's efforts to monitor and control EEE virus have been extremely successful. In the 15 years prior to the monitoring program, the State had 49 confirmed human cases of EEE. In the 15 years since its inception, the State has had only three confirmed cases, one of which was a visitor from Massachusetts that was never attributed to New Jersey in the official records (Crans and Schulze 1985). This paper summarizes New Jersey's approach to encephalitis monitoring and control with the hope that other states will modify the procedures used and develop a program that is applicable to their particular geographic area.

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METHODOLOGY OF THE SURVEILLANCE EFFORT

Establishment of Permanent Study Sites

Eastern equine encephalitis virus is monitored within its mosquito vectors at a series of study sites that were selected on the basis of: 1) a history of known virus activity based on past human cases, 2) a focus for equine cases of EEE over the years, or 3) a recent history of either human or equine cases that appear to defy our present hypotheses on disease transmission. Some of the sites have been monitored since 1975; others are rather recent and have been monitored for less than five years. The program tries to keep a balance between coastal sites that threaten human health and the economy of the resort industry and inland sites where equine cases are common. Unlike many states on the eastern seaboard, New Jersey has never had a confirmed human case at an inland area. Human cases are a coastal phenomenon that have only been confirmed from coastal residents or in persons from inland areas that visited the New Jersey coast within two weeks of disease onset (Goldfield and Sussman 1968). In coastal areas, the program monitors *Culiseta melanura*, the primary epiornithic vector, (Burbutis and Jobbins 1957, Chamberlain et al. 1958) and *Aedes sollicitans*, the only mosquito in New Jersey that has been implicated in the transmission to humans to date (Crans et al. 1986a). At inland study sites the program monitors *Cs. melanura* and *Coquillettidia perturbans*, the only mosquito that has been documented as an epizootic vector in New Jersey (Crans and Schulze 1986). Other mosquito species are collected and tested for EEE virus for research purposes if funds are available, but are not considered a part of the main surveillance thrust.

Culiseta melanura is Used as the Main Indicator of Virus in Nature

Culiseta melanura is selectively collected at each of the permanent study sites each year to determine: 1) population levels of the species as the season progresses, 2) deviations in population levels from the long-term mean, and 3) the levels of EEE virus in the bird populations that it is feeding on. Specimens are collected from a line of 25 resting boxes at each study location. The specimens are introduced to glass vials (one vial per box for statistical purposes), frozen on dry ice at the collection sites, and transported to the laboratory where they are frozen at -57°C until they are sorted. The resting box is the collection method of choice because it collects a broad spectrum of stages in the gonotrophic cycle. Resting box collections include: 1) UNENGORGED mosquitoes that are in the process of locating a host, 2) ENGORGED mosquitoes that have recently acquired a blood meal, 3) BLACK-BLOODED mosquitoes that have partially digested a recent blood meal, and 4) GRAVID mosquitoes that have digested a prior blood meal and contain fully developed eggs. We believe that this broad cross section of stages in the gonotrophic cycle increases our chances of locating infected mosquitoes in nature. We also believe that the light trap is much less efficient in detecting the infected portion of the mosquito population since it only attracts unengorged mosquitoes in numbers.

The resting box collections are identified to species on a chill table (to preserve living virus particles), pooled in groups no greater than 50 specimens within each of the aforementioned categories, triturated in mosquito diluent, and refrozen for virus isolation attempts. The New Jersey State Department of Health performs the virus isolation attempts at their laboratories and notifies the Vector Surveillance Program of the results.

All information is entered into a data base for rapid collation, analysis, and graphics. The program (written in dBase language) assimilates the information by Pool Number, divides data by Site, and calculates Minimum Field Infection Rates (MFIR values) by Site, Week, or Month. The MFIR values (isolation rates per 1,000 specimens tested) gives us a numerical rate that can be used to compare the intensity of virus transmission in different areas of the state. The computerized program allows us to compute this information as soon as the results of virus isolation attempts are known and gives us an immediate picture of EEE amplification over a broad geographic area. The information is phoned weekly to the participating county mosquito control agencies, mailed weekly in hard copy to all agencies, and published bimonthly in a "New Jersey Vector Surveillance Report."

Equine Cases are the Indicator for Accelerated Control of *Coquillettidia perturbans* at Inland Areas of the State

The New Jersey State Department of Agriculture requires veterinarians to report all suspect horse cases as soon as possible. They also require the veterinarians to submit a series of blood samples taken during the clinical course of infection and the brain of euthanized animals whenever possible. All suspect animals are tested for EEE. The results are made available to the New Jersey Vector Surveillance Program as soon as possible. County mosquito control agencies are contacted by phone, given the address of the equine case, and urged to conduct mosquito trapping for virus isolation attempts. Control by ground ULV is strongly recommended in the area of a confirmed equine case and all county mosquito control agencies are notified of confirmed, presumptive, and pending cases. Data from prior years implicate *Cq. perturbans* as the main vector to equines (Crans et al. 1986b). We do not have evidence that *Aedes vexans* and other floodwater mosquitoes are involved but most agencies engage in accelerated control that reduces the overall vector populations.

In Coastal Areas, the Physiological Age of *Aedes sollicitans* is Used as the Main Indicator of Risk for Transmission to Humans

Aedes sollicitans populations are monitored twice weekly from June through October at numerous stations along the New Jersey coast. Field technicians record multiple one minute landing rates to determine the mean number of mosquitoes coming to bite per minute. They also collect and freeze specimens for physiological age determinations according to the procedures outlined by Detinova (1962). In the laboratory, the ovaries of no fewer than 20 specimens from each collection station are dissected in distilled water, dried on a microscope slide, and examined for parity. The presence of tracheolar skeins in the ovaries indicates a nulliparous mosquito (a mosquito that has not yet laid eggs); extended tracheoles indicate a parous mosquito (a mosquito that has laid at least one batch of eggs and has, therefore, had at least one prior blood meal). The data are used to calculate the percentage of parous mosquitoes in the biting populations at each station.

The number of parous mosquitoes coming to bite per minute is obtained by multiplying the landing rate, collected at the field site, by the parous rate determined by dissection. This yields a Vector Potential Index (parous landing rate) which is used as the main indicator of risk for transmission to humans. Control of *Ae. sollicitans* is recommended if the parous landing rate exceeds ten per minute in an area where EEE virus is known to be circulating in *Cs. melanura*.

Monitoring physiological age to determine transmission risk is a technique that was developed by Russian scientists and put into practice by the British, and others, to reduce the rate of malaria transmission in malarious regions (Detinova 1962). In those studies, the aim was to assure that no mosquitoes lived longer than nine calendar days, the amount of time required for the malaria parasite to reach infectivity in the vector. Control methodology involved spraying the inside of domiciles with a persistent pesticide because the vector entered houses, fed on sleeping humans, and rested on the walls before leaving to deposit its eggs. Over a nine-day time span, the average anopheline mosquito would feed three times, thus, the probability that the mosquito would contact the pesticide during its first nine days of life was high. The technique kept the age of the biting population "young" and the percentage of mosquitoes that were capable of transmitting malaria dropped markedly.

Aedes sollicitans is a brooded mosquito and the logic developed by the British can be applied to reduce vector potential for EEE. In a brooded mosquito, high mosquito populations are usually an indication of a fresh emergence. Annoyance can be considerable but the adults are mainly nulliparous, thus, vector potential is low. Over time, annoyance declines but the adults become parous and the vector potential of the biting population increases. The technique of measuring vector potential by measuring the number of parous mosquitoes coming to bite yields the index that New Jersey uses to institute control for the prevention of human disease. When EEE is known to be cycling in *Cs. melanura*, chemical control is directed toward "old" populations of *Ae. sollicitans*. This results in spot treatments in designated areas of the State rather than broad scale chemical coverage during emergency periods.

CONCLUSIONS

New Jersey's approach to encephalitis control has worked well over the years and we no longer see the massive air sprays that characterized the 1950s and 1960s. The program works because the state and county agencies that are responsible for mosquito control are kept aware of the status of EEE and its mosquito vectors every season. The system also works because it is based on science and supported by ongoing research. The New Jersey State Mosquito Control Commission has funded much of the research that is now put into practice and continues to support research that is needed for the future. Eastern equine encephalitis is still a threat to coastal residents and the economy of the resort industry in southern New Jersey. Encephalitis prevention, however, is now a cooperative effort in New Jersey; and it is doubtful that the State will experience the panic and hysteria that accompanied the 1959 outbreak and the EEE episodes that characterized the 1960s.

REFERENCES CITED

Burbutis, P. P. and D. M. Jobbins. 1957. *Culiseta melanura* and eastern equine encephalomyelitis in New Jersey. Proc. N.J. Mosq. Exterm. Assoc. 44: 68-78.

Chamberlain, R. W., W. D. Sudia, P. P. Burbutis, and M. D. Bogue. 1958. Recent isolations of arthropod-borne viruses from mosquitoes in the eastern United States. Mosq. News. 18(4): 305-308.

Crans, W. J., J. D. Downing, and A. A. DiEdwardo. 1976. The emergency surveillance program in New Jersey for potential mosquito vectors of viral encephalitis in 1975. Proc. N.J. Mosq. Exterm. Assoc. 63: 82-93.

Crans, W. J:, J. McNelly, T. L. Schulze, and A. Main. 1986a. Isolation of eastern equine encephalitis virus from *Aedes sollicitans* during an epizootic in southern New Jersey. J. Am. Mosq. Control Assoc. 2(1): 68-72.

Crans, W. J., L. J. McCuiston, and T. L. Schulze. 1986b. Evidence incriminating *Coquillettidia perturbans* (Diptera: Culicidae) as an epizootic vector of eastern equine encephalitis. II. Ecological investigations following an inland epizootic in New Jersey. Bull. Soc. Vector Ecol. 11(1): 185-190.

Crans, W. J. and T. L. Schulze. 1985. Eastern equine encephalitis in New Jersey during 1984. Proc. N.J. Mosq. Control Assoc. 72: 34-39.

Crans, W. J. and T. L. Schulze. 1986. Evidence incriminating *Coquillettidia perturbans* (Diptera: Culicidae) as an epizootic vector of eastern equine encephalitis. I. Isolation of EEE virus from *Cq. perturbans* during an epizootic among horses in New Jersey. Bull. Soc. Vector Ecol. 11(1): 178-184.

Detinova, T. S. 1962. Age-grouping methods in Diptera of medical importance. WHO Monograph No. 47, Geneva, 216 pp.

Goldfield, M. O. and O. Sussman. 1968. The 1959 outbreak of eastern encephalitis in New Jersey. I. Introduction and description of outbreak. Am. J. Epidemiol. 87(1): 1-10.