

Community-based Dengue Control: A Description and Critique of The Rockefeller Foundation Program

Scott B. HALSTEAD

*Deputy Director, Health Sciences
Rockefeller Foundation
1133 Avenue of the Americas
New York, N. Y. 10036, U. S. A.*

For the public health worker the history of the control of *Aedes aegypti*-borne diseases offers a very sobering lesson. Our forebears were considerably more successful and, let's face the truth, more competent in the management and prosecution of a technical control service than we. All this competence is in the relatively recent past. Brazil, which had experienced recurrent severe epidemics of yellow fever, proposed to the Pan American Health Organization (PAHO) in 1947 that it undertake a campaign to eradicate *Aedes aegypti* from the Western Hemisphere (1). Dr. Fred L. Soper, during the period of this eradication campaign, was the PAHO Director. During the 1930's Soper, as a Foundation officer, had inadvertently discovered that a highly organized program to find and destroy *aegypti* larval breeding sites could reduce premises indices to zero (2). The addition of specially qualified teams designated to find "hidden foci" of breeding were responsible for eradicating *Aedes aegypti* in Brazil. This was before the discovery of DDT, and when oil, Paris Green, the pyrethrins and sulfur smoke were the only available larvicides or adulticides.

Certainly, the conditions for breeding mosquitoes in urban areas in the era of the 1930's to 1960's could not have been better than today. Under these circumstances, Soper and a cohort of country managers organized and carried out successful campaigns which eradicated *aegypti* as shown in Table 1. Can we attribute this success to unparalleled leadership? To an era of governments run by strong men? To an epoch when sanitary reforms were being invented and implemented as a matter of course?

We may never know.

Whatever the case, soon after Dr. Soper's retirement, the United States abandoned its eradication program in 1969. There followed a general decline in political interest in *Aedes aegypti* control. Rather quickly, the mosquito was exported from the United States throughout the Americas, becoming re-established in the 1970's and through the 1980's.

Meanwhile, outside the Western Hemisphere, the *Aedes aegypti* situation was steadily deteriorating. The factors most responsible for the increase in *Aedes aegypti* and the growing 20th century dengue pandemic have been identified many times: *World War II*

Table 1. PAHO eradication program for *Aedes aegypti* completed

| DATE | COUNTRY |
|------------------------|---|
| September-October 1958 | Bolivia, Brazil, British Honduras, Canal Zone, Ecuador, French Guiana, Nicaragua, Panama, Paraguay, Peru, Uruguay |
| September 1959 | Guatemala, Honduras |
| August 1960 | El Salvador |
| October 1961 | Chile, Costa Rica |
| September 1963 | Mexico |
| September-October 1965 | Argentina |

Compiled from the data from the the PAHO Resolutions, 1971.

Note: This Table represents only the dates at which initial eradication programs were completed, and does not show which areas later became reinfested.

From Slosek (4)

destroyed urban infrastructures resulting in a great increase in domestic water storage. The war also introduced large numbers of susceptible human beings into the dengue-endemic zone and which created refugees who, themselves, assembled temporary structures which provided breeding sites for *Aedes aegypti*; the post-war population explosion, which more than quadrupled the population of tropical Asia; the migration of people from rural to urban locations; and the steady deterioration of urban habitats.

Beyond these macrophenomena, I believe we can recognize failures in societal and health system organization which prevented the creation of effective vector control services or which led to the deterioration of such services. These include:

1. *Failure to recruit and retain professional competence.* Many national health systems either have not created an adequate number of attractive positions for vector control specialists or cannot provide career incentives which permit retention of skilled professionals.
2. *Failure to staff vector control programs with adequate number of trained professionals* at an appropriate disciplinary mix. There is little recognition that vector control teams require a mix of administrative, entomological, biological, epidemiological and communicative skills.
3. *Failure to apply sound managerial and scientific practices* to vector control programs, including the appropriate use of research to monitor and evaluate program outcomes.
4. *Failure to train high quality professionals.* As has been documented in an extensive recent study by Gratz (3), opportunities for graduate-level education and research in vector control are nearly absent in a region which holds a fifth of the world's population and beats a large number of well-established and high quality universities and research institutes.
5. *Failure to provide adequate funding.* Inadequate application of pesticides may hasten the emergence of resistance in mosquitoes making control problems worse. No program

may do less harm than a poorly conceived one.

6. *Failure to obtain public consent* and legislative sanctions for vector control programs.
 7. *Failure of political will.* Underlying each of the above has been a permeating, self-defeating expectation of failure at the budgeting, legislative, planning and execution stages of vector control programs.

The global and national forces and systemic problems which have been identified have contributed to a 20th century dengue pandemic and a fatal sub-epidemic of DHF/DSS which is its consequence. In 1987, the Rockefeller Foundation, which had been identified with the development of methods which led to the near eradication of *Aedes aegypti* in the Western Hemisphere, wondered if the time had come to find new methods of vector control. A meeting of vector control experts was called at the Parsons Island Conference Center in Chesapeake Bay. The conferees agreed that, whether for political, cultural or technical reasons, top-down, governmentally organized and administered programs could not be expected to succeed as the only approach to vector control in the modern era. A new strategy was needed which builds from the bottom-up, deriving from the consent and voluntary participation of the population at risk.

At the same time or before the Foundation's initiative, many others had advocated and practiced community-based vector control. As the DHF/DSS problem has escalated, the number of community-based *Aedes aegypti* control strategies, research and demonstration programs has increased. The strategies and science underlying this movement have not always been clear. In the interest of opening a dialog, the origin, strategy, history, successes and failures of the still-young governments of Mexico and Honduras, Rockefeller Foundation, Centers for Disease Control, Johns Hopkins School of Hygiene and Public Health program will be presented and discussed.

Rockefeller Foundation Program

STRATEGY – The Foundation's program was created around the concept of integrating community-based control methods into standard national vector control programs. To do this, it was decided to define the minimal composition of a vector control team. Such a team should be composed of a team leader (preferably, an entomologist), a program administrator, an epidemiologist and a social scientist. To train such a team it was decided to provide a year-long didactic interdisciplinary educational experience (MPH at Johns Hopkins) and a year-long field training program in Puerto Rico. The latter was supervised by the staff of the San Juan Dengue Laboratory of CDC's Vector-Borne Disease Control Division. Following their training, teams were to return home to designated study sites where they would test interventions directed at or organized by communities. Interventions which produced reliable reductions in breeding sites or larval indices were to be evaluated for scale-up to national level.

HISTORY – In the summer of 1988, the governments of Mexico and Honduras nominated candidates for training. In May 1989, Dean D. A. Henderson awarded Master of Health

Sciences degrees to nine graduates in a ceremony held in San Juan, Puerto Rico. During their formal training the fellows took a core curriculum including International Health, Epidemiology, Computing, Biostatistics, Health Policy and Management, Entomology and Social Sciences. Persons designated as team managers took additional entomology training; social scientist-designees had enriched training in social science and program administrators, took additional management training.

At the very outset, the program encountered two problems. First, only physicians were in the selection pool as candidates for training. Entomologists and social scientists were simply not available. Second, candidates did not come from guaranteed positions in national health ministries.

In May 1989, the Mexican and Honduran teams established residence in the Puerto Rican towns of Caguas and Ponce, respectively. There the teams took part in an evaluation of a new grade school curriculum on dengue and *Aedes aegypti*. This featured homework assignments to identify and destroy larval breeding sites. Entomological surveys done in pupil's households before and after teaching sessions revealed no significant reduction in the number of containers which might potentially breed *Aedes aegypti*. Nor were larval breeding sites or the density of breeding reduced. This was an important lesson because it is often assumed that teaching, learning and behavior are connected. The children scored well on knowledge tests, but, significant behavior modification could not be detected.

Next, the teams organized de-novo interventions; the Hondurans organized a Project Head Start community teach-in. This ended with a small fiesta and a radio talk show. The Mexicans organized a photonovella. This community written drama linked failure clean-up patio to a case of dengue hemorrhagic fever. Each of these two interventions were tested with pre- and post-intervention entomological surveys. These showed modest but significant reductions in the disposable containers which could serve as breeding sites for *Aedes aegypti*.

The teams learned an essential entomological lesson: that pre- and post-intervention studies require a carefully selected control site where no intervention is undertaken (or a shamintervention is carried out) but a pre- and post-entomological survey is done. In several surveys there were dramatic reductions in the number of potential and actual breeding sites between the first and second survey. But, these were due to seasonal changes or, on one occasion, to a holiday which had prompted an annual clean-up.

Finally, the Mexican team invented a new house index which is particularly useful in community-based mosquito control studies. Now called the Maya Index, it describes mosquito breeding in three types of containers; disposable, non-disposable but controllable, non-disposable and non-controllable. By "disposable" is meant containers which, in the view of the householder, have no value and could be discarded. Up to 80% of all potential breeding sites were disposable e. g., tin cans, plastic bottles, glass bottles, broken plastic or glass objects, rubber tires and so forth. Non-disposable containers from which

Aedes aegypti breeding could be prevented included ceramic jars, containers holding water plants, and traps, tubs, animal feeding dishes and so forth : Each of these containers might either be emptied of water and inverted, or periodically emptied of water and, in the case of large containers, scrubbed to remove adherent mosquito eggs. Non-disposable, non-controllable containers are those which require professional identification and attention. These include roof gutters, plant axils, bamboo ends, tree holes and other hidden breeding sites.

In Mexico and Honduras, where they have been since July 1990, the teams are working in the cities of Merida and El Progreso, respectively. Merida, a city of 300,000, is the capital of Yucatan State and located near the Caribbean on the Northwest coast of the Yucatan peninsula. El Progreso, a town of 50,000, is a few kilometers from San Pedro Sula, near the Caribbean on the east coast of Honduras. El Progreso is in an area of rapid growth and industrialization ; Merida is a commercial and tourist center, heavily populated by the descendants of Mayan Indians.

Both groups have invested studies on copepods as a mechanism of low cost vector control. These insects are thought to be accessible to use by the general population. The Mexican team has largely used drama to teach about *Aedes aegypti* breeding with lessons designed for primary school children. Special scripts have been written for the Yucatan puppet theater and shown on local television. In Honduras, an extensive community network has been developed and, using health volunteers, an integrated, multi-disciplinary program aimed at cholera, malaria and dengue control has been mounted. In this program the emphasis is on improvement of compounds, streets, sewage systems and water supply. Specific interventions have been designed to test health volunteer and household compliance with the introduction and maintenance of copepods to control *Aedes aegypti* breeding in water standing in wash tubs.

CRITIQUE—In neither country did economic or political conditions permit the composition of vector control teams as they had been designed. In Honduras, three of the team members secured assignments in the health ministry. One member works full-time at the El Progreso study site and heads the community-based dengue control project. One member heads the national vector control program and the other has an important administrative position. The lack of an entomologist and a social scientist has been a serious problem. Entomological input into study design and execution has not achieved the standard of excellence required for a research project. Social scientists have been recruited from the University of San Pedro Sula. While this has provided scientists who enjoy familiarity with the Honduran milieu, the kind of broad-gaged individual that had been visualized as a member of an interdisciplinary vector control team has not yet been found. This group has not yet mastered research which permits the testing of discreet educational or social science interventions for their impact on mosquito breeding or on the number of containers providing possible breeding sites for *Aedes aegypti*. It remains to be determined if these problems can or will be solved in the future.

In Mexico, the ability to integrate graduates from the training program into the national health service was particularly poor. One of the five graduates serves as assistant to the Deputy Secretary of Health located in Mexico City. Two graduates are full-time faculty members of University of Yucatan, Where they run a dengue diagnostic and research laboratory. This husband and wife team directs the community-based dengue control program in Merida. Two other graduates, an entomologist from the University of Chiapas and a physician from the school of medicine at Guadalajara, have left the program entirely. To compensate for these losses entomologists and biologists from the University of Monterrey have joined the vector control research project. Unfortunately, it has not been possible to assemble a complete team in Merida. The most important gaps include a team leader and an entomologist. For all practical purposes this has meant that intervention research as such has not been designed or tested. As in Honduras, social scientists have been recruited from the local university.

A cursory review of the literature on community-based control of *Aedes aegypti* demonstrates an almost complete absence of carefully designed and tightly executed intervention studies. This is particularly unfortunate since pre- and post-intervention entomological surveys offer an objective and highly quantitative measure of behavioral outcomes relating to mosquito breeding. Thus far, community-based control programs appear to be centered on process, on goal setting and on good intentions. There is no more unforgiving judge of the intensity and completeness of source reduction campaigns than the gravid female *Aedes aegypti*. Humans who hope to defeat this formidable foe must learn to be equally dispassionate and disciplined in assessing the outcome of vector control activities.

Conclusions

Any possible success in community-based vector control programs will require a careful description of and agreement on a set of short and long term objectives.

SHORT TEAM GOALS—The near-term objective of community-based *Aedes aegypti* control programs is to design messages, or develop and test behavior-modifying interventions which will shift a significant portion of source reduction from the public sector to the private householder. Community-based control programs should not be designed to replace national, provincial or district vector control programs or displace leadership from the public sector to the “community.” “Community-based” should be interpreted as community-participation. In testing interventions, care should be taken to assess the length of time, or the number of times any particular intervention can be implemented successfully. “Burn-out” is likely to be a serious problem, particularly if early interventions are reasonably successful. Also, the disappearance of a health problem can significantly reduce incentives to participate in meaningful source reduction activities.

LONG TERM GOALS—The real value of sustained efforts to educate a population on risk

avoidance is to “redefine the unacceptable.” It is this shift in public opinion which provides a mandate to leaders. When the general public regards as “unacceptable” the breeding of disease-bearing mosquitoes in and around homes, many options for the control of mosquitoes will become available. One option is the model provided by the New Orleans Control Board which was formed in response to public pressure to reduce nuisance mosquitoes in the New Orleans area. An efficient year-round professionally managed vector control program funded from tax revenues has kept New Orleans relatively mosquito-free for more than 25 years. Perhaps a better model is the California mosquito-abatement districts in which taxpayers provide funds to hire private sector vector control firms who bid competitively for annual mosquito abatement contracts. Those companies which perform the best work are rewarded and survive.

It will be evident that health messages and widely held preferences for risk abatement require sensitive and compliant political systems. When the day comes that politicians run for office on their pledges to improve public health and when an electorate holds public officials responsible for redeeming their pledges, then is the time when “unacceptable” conditions will be changed to improve human health. It is in this way that health education messages can be transformed into “political will.” In democracies, it *is* possible that the expressed wishes of communities can be translated into national-scale programs.

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