7. EVALUATION OF PREVENTION AND CONTROL PROGRAMS

Epidemiologic Evaluation

The purpose of epidemiologic evaluation is to ensure that valid and useful evaluation results are readily available to influence policy and program decision-making. The strategy should be designed to help identify those programs to be evaluated, and, when this should occur, what methods should be used and how the evaluation results should be used.

Evaluation planning should be forward-looking and systematic rather than *ad hoc*. To anticipate future information needs, action must be taken to ensure the production of timely information specifically useful for measuring program performance. As programs are evaluated at different stages of their development, program effectiveness data can be incorporated into planning and budget proposals. Evaluations should be designed so as to produce information that can assess the program's contribution.

Evaluation Planning

One way to approach program evaluation is to subject each program (or project) to a set of questions that describe the program in evaluation terms, determine its evaluation history, and identify additional information for evaluation needs. The following questions suggest information that could be collected to plan for future evaluations.

1) Are goals/objectives clearly stated?
2) Do goals/objectives directly relate to the program's mission?
3) Does the program's design set forth sound reasons to expect success?
4) Is the program being correctly implemented? What is the cost of implementation?
5) Are there significant changes in program direction or policy that influence the effectiveness of the program or components?
6) What evaluations have been completed?
7) What is the nature and quality of the data and/or information on the program's success?
8) Is there evidence of the relative cost-effectiveness of specific programmatic activities?
9) What evidence is there that evaluation information is used in managing the program?
10) What do evaluations reveal about the effectiveness of the overall program or specific activities?
11) What additional evaluation information is needed at this time?
12) What are the future plans for evaluating the program?

The answers to these questions will suggest the types of evaluations that should be planned. Overall, evaluation studies are either formative—which focus on the structure and process of a program—or summative—which focus on the outcomes of a program. Within these general categories, there are many types of studies and methods, but four basic types are of most importance.

- **Evaluability assessment**—designed to examine the readiness of the program, particularly new programs, for process and/or outcome evaluation. Programmatic inputs are examined, and an assessment is made of the links between program activities and outcomes. The evaluability assessment provides an understanding of the mechanics of the program, identifies the stakeholders, examines the program objectives and indicators for success, and results in immediate feedback for program improvement.
- **Process evaluation**—carried out at some time in the program's life to determine how and how

well the delivery goals are being met. The basic questions are: "Is the program reaching the appropriate targets/clients?" and "Is program implementation consistent with program design?" This type of evaluation may involve surveys, record keeping, or direct observation.

- **Outcome evaluation**—conducted at intervals during an ongoing program to identify program consequences and to establish that the consequences are attributable to the program. It is important to document whether or not the program makes a difference or what program activities work better. Outcome evaluations usually involve randomized designs and experimental methods.
- **Economic evaluations**—consist of comparative analyses of various courses of action, in terms of their costs and their consequences. The important question to answer is "What is the value of the outcome in comparison with the resources required?" The basic types of economic evaluations are cost-minimization analysis, cost-benefit analysis, cost-effectiveness analysis, and cost-utility analysis.

The use of evaluation results must be part of the evaluation's design and implementation. Several suggestions for increasing the relevance of an evaluation include:

1) Involve program managers and decision-makers during the design's planning stages, to make sure that the questions asked satisfy their information needs and that planned approaches will yield usable results.

2) Make sure that the evaluation results are timely, in other words, that they are available when needed for policy and program decision-making.

3) Present the final report and recommendations in a style and a format that are compatible with the experience, skills, and interests of users.

4) Provide clear-cut recommendations that can be implemented in the near future, not several years later.

5) Insure that the evaluation and recommendations are feasible and credible.

6) Make the final report and recommendations acceptable (i.e., avoid criticism and remain sensitive).

Dengue/DHF is a disease in which prevention of human infection depends on controlling the mosquito vector. Consequently, there must be epidemiologic evaluation of the control program, including several components such as proactive surveillance, educational activities, and mosquito control. Entomological evaluation is covered in the section beginning on page 73, and will not be discussed here. Evaluation of educational materials and/or programs is complicated and involves the use of social scientists. Only surveillance evaluation will be briefly discussed here.

Evaluation of the surveillance system should concentrate on defining the sensitivity of the surveillance system and its flexibility during periods of high and low transmission. The evaluation itself should enhance the surveillance system's use, promote its expansion within the health services to make it representative of the population being monitored, and make it more acceptable to its users.

Evaluation of a dengue surveillance program involves a close working relationship between epidemiologists and the diagnostic laboratory, which determines whether the cases reported as dengue are, in fact, dengue cases or cases of another clinically related illness. Evaluation, based on laboratory testing, should continue during both inter-epidemic and epidemic periods, and, when properly used, will generally document under-reporting during periods when no apparent dengue transmission is occurring, and over-reporting during periods of epidemic activity. The laboratory confirmation rate of reported cases can provide extremely useful feedback to the physicians and health officials responsible for the case reporting system. It is probably the most important type of information needed to increase the sensitivity of the surveillance system. Specifically, case reporting systems must be closely monitored, in order to insure that lack of interest or a low "index of suspicion" from participating physicians, clinics, and hospitals do not result in such gross under-reporting that the epidemic reaches almost peak transmission before it is recognized.

Seroepidemiologic surveys can be an important component of epidemiologic evaluation of surveillance systems. Following a period of increased or epidemic transmission, properly planned and conducted surveys can provide valuable information on age stratified and geographic transmission rates. Both blood samples for serology and questionnaire data should be collected. Such estimates of incidence and prevalence provide the data needed to make decisions on the future direction of control programs.

Entomological Evaluation

Entomological evaluation is especially appropriate for assessing vector control programs in areas with high infestation levels (see Table 15, in the section "Current Approaches for Surveillance and Control," beginning on page 34.) Evaluation will determine the efficacy of an intervention and will provide information for making decisions on the appropriateness of the methodology, the timing and frequency of the activities, and other control aspects. It not only provides assurance of effectiveness, but it also can help identify reasons for failure. When failures occur, carefully designed and executed evaluation measures will provide data for selecting and planning alternative interventions in the future.

The techniques used in most entomological evaluation procedures, will be the same as those used for surveillance purposes (see the section on vector surveillance, beginning on page 28). The entomological techniques themselves, as well as the interventions to be applied and, where appropriate, the equipment and product to be used, should be evaluated, especially when new procedures are introduced.

For evaluating preventive measures (e.g., source reduction and management of container breeding sites within an integrated program), the traditional entomological parameters (e.g., house, container, and Breteau indices) will give some indication of the program's overall impact. However, they will not detect changes in the relative adult vector abundance. The relative importance of different container types in a given locality may be determined by computing the Breteau index for each type. An assessment of the extent to which discarded, non-essential containers have been eliminated or removed and the extent to which useful or essential containers have been appropriately managed or modified, should be considered for inclusion in program evaluation, especially when community-based strategies are being applied.

With respect to evaluation of larviciding and biocontrol measures, the efficacy and duration of control can be directly measured using standard larval survey and bioassay techniques.

For evaluating space sprays used for emergency suppression of adult vector populations, bioassay cages and droplet collection devices can be used to ascertain the penetration of spray droplets into exposed and sequestered sites in and around houses. However, the impact of sprays on caged mosquitoes does not necessarily reflect mortality in the natural mosquito population. If resources permit, the effect of treatment on the wild mosquito population should be carefully assessed. This can be achieved by directly measuring changes in adult density, using either landing/biting or indoor resting collection techniques or indirectly by measuring oviposition rates. The latter approach, using the enhanced CDC ovitrap, has proven both practical and sensitive, and is less demanding of skills, personnel, and resources than are adult collection methods.

Information Systems for *Aedes aegypti* Control Programs

The information needs of ongoing control programs based on primary health care strategies differ widely from those of time-limited eradication campaigns. In addition to the use of insecticides, contemporary programs incorporate other strategic approaches for the management of vector populations, including biocontrol methods such as larvivorous fish, and source reduction that, in turn, incorporates several options such as the destruction or removal of containers or their proper storage, mosquito proofing, and cleaning. Because eradication campaigns historically relied almost exclusively on the application of insecticides to all potential larval habitats, little importance was given to differences in larval ecology from locality to locality. In the context of the primary health care approach to vector control, a clear understanding of larval ecology and human behavior is required at the community level, so that health education and health promotion efforts can be focused on priority habitats, using the most appropriate strategies for container management, modification, or elimination. Moreover, the concept of "species sanitation" must be broadened to include mosquito species other than *A. aegypti* (e.g., *Culex pipiens quinquefasciatus*) and rodents, cockroaches, flies etc. which are perceived as nuisances and health problems by the community.

Priorities for operational coverage should be determined according to risk factors that only partially deal with vector densities traditionally measured using the house and/or Breteau and/or container indices. Other risk indicators include human population density, water supply adequacy, and availability and quality of solid waste disposal services. These indices are not part of the conventional data-gathering process.

In modifying and adjusting an information system for contemporary program delivery the following points should be considered:

- In addition to gathering data, the system should support the process of program development, planning, and decision-making.
- In keeping with more dynamic epidemiological control approaches, the system should be readily adaptable to local demographic, geographic, and ecological situations in accordance with the demands of the program.
- The system should provide information that facilitates the identification of new combinations of control tactics that could be implemented as integrated strategies.
- Databases should include community demography; knowledge, attitude, and practice (KAP) survey results; and other external data sets needed for planning and development of social participation strategies; the system should readily exchange information to and from other elements of the primary health care program.
- The entomological monitoring and surveillance system should be closely linked to the disease surveillance system.

Data Categories

Two major categories of data can be identified: internal, those that are generated by the program itself, and external, those that are generated from other sources.

Types of Internal Data

In terms of internal data, the basic unit of data collection is the house, premise, or building. For program delivery (i.e., applying control measures), data are required from every premise visited; details should include whether or not the control measures were actually applied, or partially applied, and the reasons for any difficulties encountered. While this data set warrants routine collection, other parameters, such as mosquito population changes or larval habitat characteristics, can be measured on a sampling basis (see the section on vector surveillance, beginning on page 28) or by targeted research.

Types of External Data

Demographic data on the distribution and density of the human population, settlement characteristics, and conditions of land tenure (e.g., squatter, owner/occupier, house styles, education, and socioeconomic status) are all interrelated, and are of fundamental importance for planning purposes and for assessing the risk of acquiring dengue. Knowledge of the water distribution system, its quality and reliability, as well as domestic water storage practices also are considered vital.

Of the other basic services, solid waste disposal ranks high in importance, since geographic coverage and the frequency and quality of collection may directly affect the density of vector habitats in a given locality. Sewerage and excreta disposal methods can be of particular significance in terms of the breeding of *Culex pipiens quinquefasciatus* and the proliferation of other insect and rodent pests.

To a greater or lesser extent, the delivery of these basic services are factors in determining the infestation characteristics of peridomestic mosquitos, rodents, and other pests. Knowledge of their quality and coverage provides insight into vector ecology in any given locality, and can be utilized to plan targeted source reduction or other management strategies or to organize epidemic intervention measures.

Meteorological variables, especially rainfall, directly influence vector populations by inundating outdoor container habitats. In addition, in some areas or during periods of limited rainfall, more extensive potable water storage may be needed. Unlike other external data types for which only periodic, perhaps annual, updates are required, meteorological data may warrant frequent monthly or weekly collection reviews, if it is to be of value in determining seasonal trends of the vector population and human behavior as it relates to peridomestic water storage.

The more a particular program promotes intersectorial strategies and social participation in vector control, the more relevant that data on community organizations such as non-governmental and private voluntary organizations, schools, youth organizations, and churches will be. Other government agencies with which collaboration can be sought should be identified. Local patterns of communication, language, and literacy skills will be especially important for developing health education strategies and community mobilization.

Economics of Control Programs

In most countries of the Americas, it is difficult to estimate how much dengue prevention and/or

control programs spend annually. Often, dengue (or *Aedes*) control programs function as branches of malaria control programs and/or operate sporadically in response to real or perceived emergencies. Supplies, equipment, and personnel are not continuously available. In emergencies, or under public pressure, expenditures of national funds or donations can be very high, especially for insecticides, while little money is available for routine operations at other times.

As a result, substantial funds are spent on unstructured activities, the results of which are difficult or impossible to evaluate. It is important, therefore, that economic factors be considered during the reorganization or strengthening of dengue control programs recommended in this document.

Information of this nature is essential for planning, evaluation of the cost-effectiveness of individual control measures, comparison of different control measures, and evaluation of new methods.

Examples of the types of cost estimates that should be obtained include the following:

Vector Control Costs

Chemical

It is not enough merely to estimate the quantities of insecticide required. Costing should begin with the size of the population to be protected and the number of premises or the area to be treated, as well as the personnel requirements (at all levels) based on the frequency of application. Personnel costs include expenditures on training, safety equipment, and per diem or overtime when applicable. Initial capital costs for equipment, depreciation, and/or shared usage with other programs must be considered. Operational costs, especially for ULV space spraying, should include machinery and vehicle maintenance, and frequent calibration of pumps, as well as the costs of monitoring vector populations, penetration of droplets, and the level of compliance by the local population, depending on the control measures employed. The compilation and analysis of data also involve real costs.

Environmental management

Source reduction programs are often thought to be less expensive alternatives to chemical control measures. However, this may only be true for short-term ("clean-up") campaigns. Long-term success in environmental management requires health education, public health communication, and development of community cooperation. Educational materials, promotion through the media, introduction of sanitary concepts into school curricula, training teachers, etc., may involve considerable costs. Some of these costs can be covered by other sectors, (such as educational, municipal, or private), and such collaboration should be encouraged.

Environmental management campaigns, especially clean-up campaigns, may fail from a lack of trucks and facilities for solid waste disposal. Communities, especially cities, need either to invest in such equipment or must make arrangements to rent or borrow it from other sources.

As with chemical control, environmental management programs must be evaluated and the vector and disease data organized and analyzed; all of these activities will involve costs.

Laboratories (surveillance)

Most national laboratories that perform serodiagnosis or virus identification for dengue will also be responsible for other diagnostic services (measles, polio, etc.). The cost of the dengue component must be adequately funded based on an analysis of the number of samples processed, the reagents, and the equipment required. Long-term investment must be made, and accounted for, in the training of professionals and technicians. Refresher training sessions need to be routinely scheduled.

Coordination with hospitals and medical supplies

In addition to coordination among its component parts, the program requires coordination between the curative and preventive services and these expenses should be recognized. An information exchange network is required, and depending on the endemic status of dengue/DHF, and the potential for epidemic situations, hospital supplies and equipment must be readily available and be replaced and/or updated regularly. A list of such materials is provided in the section on "Organization and Requirements for Medical Care," beginning on page 60.

Each country should estimate the costs associated with individual case management and with cooperation and information from neighboring countries and international organizations, and estimate requirements on an annual or biennial basis.

Surveillance

Guidelines for entomological, epidemiological, and viral surveillance methods are given in the chapter on "Surveillance," beginning on page 23. These can be used as a framework for estimating the size of the required surveillance system in a given city, state, province, or country, as well as the cost of the surveillance that, in addition to laboratory costs and information exchange, will include expenditures for collecting and processing samples in the field.

Community Participation, Health Education, and Communication Costs

In addition to the costs that have already been mentioned, liaisons must be established with community groups, in order to provide technical assistance where required and to determine how the health authorities can assist those groups with their individual and collective efforts.

Health education and social communication activities will play significant roles in community participation efforts; consequently, it is extremely important to estimate their cost. The recording of actual costs of health education, communication, and community participation should also be made on an annual basis.

Other Costs

Each national program will have additional cost elements, depending on the governmental structure and the requirements of their accounting systems. These may include depreciating capital investments (vehicles, pumps, etc.); shared use of facilities (warehouses, administrative services, etc.), and in-country purchase and delivery of supplies (insecticides).

In summary, once the costs of the components of individual dengue control projects have been determined, it will not only be possible to estimate total costs, but also to identify where savings may be gained through intersectorial collaboration with other government agencies and the private sector. The cost data collected, along with the epidemiological and entomological data, provide an initial framework for conducting cost-effectiveness studies of different interventions used in the national program. New methods and improvements of existing methods can be more effectively evaluated for operational use when their economic benefits or limitations are fully understood. The benefits of dengue control programs should be considered in light of the economic as well as the health impact of epidemics, as detailed in the chapter on "Dengue and Dengue Hemorrhagic Fever," beginning on page 3.