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DENGUE PREVENTION AND CONTROL

Country dengue control programs are predominantly vertical and mostly based on the use of insecticides. Most countries focus on addressing emergency situations and place less emphasis on effective, long-term actions. This, along with the decentralization of health services, high infestation rates with the vector *Aedes aegypti*, and lack of adequate water supply and solid waste management for the population, exacerbate the problem.

This document is presented to the Executive Committee in light of the increase in incidence of dengue epidemics and of the more severe form of the disease, dengue hemorrhagic fever/dengue shock syndrome (DHF/DSS), which has created an alarming situation in the Americas. If immediate action is not taken, DHF will become as endemic in the Americas as it is in Asia, where some countries report hundreds of thousands of cases per year.

In 1995 the Directing Council adopted Resolution CD38.R12 in order to address the magnitude and gravity of the emergence of DHF in the Region, and it recommended that Member States strengthen their programs. Few successful steps have been taken since then, and the situation is now much more grave.

Some issues for the consideration of the Executive Committee are:

- How to effectively build political commitment to prevent dengue, including strong intersectoral actions;
- Promotion of government and private sector advocacy for higher financial commitment to dengue control;
- The role of insecticides in dengue control programs and whether they are used for technical or political reasons;
- The importance of community participation, health education, and social communication in dengue control programs with an emphasis on behavioral change;
- Source reduction of breeding sites as the means to sustain control over the vector;
- The disastrous path we are going down in the face of DHF: how can we prepare for, avert, or revert it?
- How can timely dengue case reporting be made uniform throughout the Region to improve information-sharing between neighboring countries?

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FACING THE DENGUE THREAT: A BLUEPRINT FOR ACTION

1. Introduction

The ever-increasing threat of dengue fever (DF), dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS) can be seen throughout the world. More than 100 countries are currently suffering from outbreaks of the disease. The situation in the Americas has become progressively more alarming with an increase in both DF and in the more severe form, DHF, in many countries, with a very high fatality rate.

After an epidemic in Cuba in 1981, the number of reported cases for all countries in the Region remained under 200,000 per year until the mid-1990s when a steady increase was observed, reaching a maximum report of more than 700,000 cases in 1998.

The reduction in the number of reported cases in 1999 and 2000 does not mean that the situation is getting better. On the contrary, it would not be surprising for the number of cases in the Region to continue to rise in the years to come. Underreporting of cases, combined with the fact that some countries are only reporting laboratory-confirmed cases, also create a distorted view of the actual situation and is in part responsible for the lower numbers reported in 1999-2000. In fact, during 2000 there were DF epidemics in Cuba, Ecuador, Paraguay, and Suriname as well as in five Central American countries (Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua). During the first weeks of 2001, epidemics were also reported in northern Peru and several states in Brazil.

One of PAHO's major concerns is that the countries of the Americas are now following a similar pattern of DHF to that which occurred in many Asian countries some 20 or 30 years ago. In these countries the once-relatively small number of reported cases of DHF has been rising over the years to the point where some countries are now reporting hundreds of thousands of cases per year.

In the Americas reporting on DHF cases is following a trend similar to that of Asia. The first major epidemic occurred in Cuba in 1981, where over 10,000 cases were reported. After that very few cases were reported until 1990. Since then however, there has been a steady increase and more than 10,000 cases were reported for 1997 and 1998.

Fortunately most of the dengue epidemics that have occurred in the Americas have been of DF, even though the number of cases of DHF is on the rise as well.

2. Strategies to Control *Aedes aegypti*

Most national dengue control programs traditionally have been vertical in nature and have employed methods directed toward the elimination or control of vector breeding sites and the application of insecticides against the adult vector. These have met with some success in Singapore and Cuba, for example, even though these countries have experienced periodic setbacks. Vertically organized programs usually are only feasible in countries with sustained political will and an economic commitment to maintain high-cost interventions. Countries lacking this type of commitment usually experience continued failures, meaning that even if the vector was successfully controlled in the past, the country usually experiences a reinfestation, either because the mosquito population was not completely eradicated or because surveillance and control programs were subsequently abandoned. These programs usually have also failed to secure adequate government and private sector financial commitment.

3. Key Issues for Deliberation

In preventing and controlling dengue, as in facing many other public health challenges, there is no one simple, foolproof intervention that will prevent or halt the spread of the disease. The solution instead lies in a series of concomitant actions that may well vary from country to country and even within different areas of the same country, depending on the specific circumstances.

Today the Region's dengue control efforts require the development of intersectoral partnerships and support networks, as well as sustainable environmental actions in the areas of urban planning and services such as the provision of basic water and sanitation. These efforts must be buttressed with the active involvement of individual households, communities, and local governments in the care and protection of their physical environment.

3.1 Political Commitment

Political commitment is the first and most essential building block for the development of a successful dengue prevention and control program. All levels of government must be supportive of this program from the highest level down to that of the communities and the people it serves. Adequate and rational legislation must be developed and implemented, and government agencies must be willing to improve local water supply, wastewater disposal, solid waste management, used tire disposal, and community health education and services.

In many cases, dengue prevention and control programs have depended on rather isolated self-generating actions such as providing education, instituting refuse removal, and/or applying social communication techniques. On the other hand, if intersectorial partnerships were established, along with clear guidelines for each group's responsibilities within its field of expertise, targeted adjustments could be more manageable and effective.

Clearly, countries cannot continue to work in an emergency mode of action, waiting for an epidemic to occur and then quickly mobilizing efforts as if dengue were a fire easily extinguished and then forgotten about. The fact is that as the disease's vector population increases and the indices escalate, the situation will be exacerbated, and the problem will become more difficult to manage. As the number of epidemics increases over time and as more dengue serotypes circulate and become hyper-endemic in countries, the more serious the DHF situation in the Region of the Americas will become. Therefore, governments need to take an active leadership role to ensure the success of national programs so that all sectors (education, environment, health, private industry, NGOs, etc.) are working in harmony toward a common goal.

3.2 *Proposed Intersectoral Actions*

Experience has long proven that effective dengue control is not possible without intersectoral actions, primarily on the part of government agencies. Even behavioral changes by members of a community are to some extent dependent upon government actions (through public education initiatives).

Some of the principal areas requiring intersectoral coordination and implementation include:

- Decentralization of dengue programs;
- Formal health education at all levels;
- Legislation;
- Solid waste disposal; and
- Water supply and disposal.

How can simple disease prevention and control measures be reintroduced into the basic educational program curriculum?

- *Water Supply and Disposal*

One of the major problems of dengue control efforts is the availability of vector breeding places, particularly in water storage tanks. The lack of a constant, permanent supply of water in many parts of the Region largely explains the existence of these tanks.

If municipal water authorities could provide sustainable improvements in water supply sources, the need for these containers would be reduced or their use even discontinued, thereby eliminating one of the principal sources for dengue's spread. Unfortunately, this scenario is unlikely to occur in the short term, even though the current dengue situation calls for immediate and urgent action.

- *Solid Waste Disposal*

Another primary producer of mosquito breeding sites is the plethora of unusable or useless containers that are discarded by the population in the peri-domiciliary environment. These containers have been the target of massive clean-up campaigns by dengue programs in the Region. Many times the underlying problem is that there are no systematic refuse removal mechanisms in disease-affected localities. Moreover, since community members have no place where they may dispose of these containers properly, they transport them to clandestine or inadequate dumps areas, thereby simply transferring the problem from one locale to another. For this reason, responsible city, municipality, and state agencies need to be incorporated into dengue programs through intersectoral actions that can provide a permanent solution to these breeding sites. By forging these new types of partnerships, other benefits such as recycling and improved health are also brought to the community.

Therefore, the question becomes: is it cost effective and economically viable to invest in trash collection and recycling programs?

- *Decentralization of Dengue Programs*

There is a growing trend toward decentralization of dengue control programs in many countries of the Region. Whether or not it is applicable in all cases should be evaluated. Larger countries may find more benefit in the decentralization of actions, while smaller countries, where geographic distances are shorter, may wish to evaluate the desirability of duplicating efforts if resources are particularly limited.

How can we evaluate the relativity of benefits versus drawbacks of decentralization in these cases?

- *Legislation*

Although legislation exists to regulate various aspects of dengue prevention and control programs and activities (such as fines for allowing the presence of breeding sites in homes and buildings), these are not always implemented or for some reason cannot be implemented. Means to adjust or create practical legislation (such as regulating used tire

use and circulation) must be advocated in order to reduce the disease burden. This includes increasing access to primary health care, particularly for the most marginal strata of the community; incorporating environmental basic health education at all levels, including the school curriculum; and developing policies to eliminate mosquito breeding sites through periodic removal of trash and other receptacles that attract mosquito populations.

3.3 *Insecticide Spraying*

Many dengue control programs depend primarily on the use of insecticides, yet the role of insecticides is probably one of the most frequently misunderstood aspects of dengue control. The actions undertaken to date in this area have not adequately responded to the threat of the disease, since all forms of the disease are continuing to increase, and epidemics remain a frequent occurrence. There is a role for insecticides in these programs, but many experts feel these chemicals are not being used judiciously, and their use could be reduced without compromising the integrity of dengue programs.

Insecticide use can be divided into two main approaches: those used against adult mosquitoes (adulticides) and those used against immature mosquitoes (larvicides).

- *Adulticides*

This variety of insecticides kills mosquitoes during the adult stage and is usually undertaken through space-spraying. The effect is immediate and short lasting. Space-spraying adulticides last no more than a few minutes, are only effective on the immediate adult population, and many times are not effective if conditions are less than optimum. Oftentimes, for these reasons, there is strong opposition to their use by the local population.

The use of space-spraying is recommended only during epidemics in order to target and eliminate infected female mosquitoes, thus reducing the circulation of the virus in the community. However, if inadequately or improperly applied, adulticides will have little impact on health conditions even if positive short-term political objectives are achieved. The cost of adulticides is very high and non-sustainable.

- *Larvicides*

The purpose of using larvicides is to kill the mosquito during its immature stages in breeding sites that cannot be destroyed. The effects are long-lasting but require some degree of maintenance. The use of larvicides is customary in areas without an adequate and reliable supply of water for drinking, bathing, and household cleaning purposes.

Operationally the use of larvicides in dengue control is time-consuming and requires a large number of inspectors for monitoring the situation. In addition, some sectors of the population are reluctant to cooperate with program personnel who have come to inspect the houses and apply the larvicides.

3.4 *Source Reduction*

Source reduction is defined as the reduction of the breeding source of the vector mosquito; in this sense, it is the most effective method of reducing the density of *Aedes aegypti*. Unfortunately, the prevention and control programs that have carried out these activities in the past no longer have sufficient personnel to conduct house-by-house inspections today. Resistance from some homeowners compounds this problem, and weakens the overall impact of source reduction approaches.

3.5 *Role of Community Participation, Health Education, and Social Communication*

Communities include the resident population and local industries and enterprises, NGOs, churches, schools, clubs, and other participatory associations. Since most of the breeding sites of the dengue vector are artificial containers in and around houses and buildings, actions by the population may offer the best response to sustained vector control.

When introducing control measures that depend on behavior change and community involvement, some essential social science groundwork must be undertaken beforehand with community reference groups. This includes an ascertainment of the community's knowledge, attitudes, and practices associated with dengue and mosquito breeding and feeding habits. The feeling of the general public about existing information and social and mass communication sources, other community structures, and government services is also important to disease prevention and control efforts. The knowledge of health care providers, politicians, policymakers, the media, and the private sector should also be taken into account. Monitoring and evaluation of behavioral change interventions also require regular inputs from skilled social scientists. Behavioral change surveillance indicators have to be defined and developed in order to be incorporated in the control programs along with entomological and epidemiological surveillance.

3.6 *Case Reporting*

Epidemiological surveillance and case reporting are an essential part of prevention and control programs. It is singularly important that all the countries in the Region maintain the most accurate case reporting systems possible. Information relayed to PAHO is sent to all countries so that they may be aware of the situation in neighboring countries.

Case reporting must include clinical cases (probable cases), laboratory-confirmed cases, cases of DHF, and deaths due to DHF/DSS. Some countries do not report clinical cases, thereby presenting a misleading impression of the true situation. Therefore, the reporting of clinical cases is a litmus test for the effectiveness of surveillance efforts. Clinical cases should be the guide for prevention and control programs. The laboratory confirms the presence of the virus and helps determine the virus serotype that is circulating and the severity of the situation. However, some countries do little, if any, case reporting (Annex A).

3.7 *Frequency of Case Reporting*

It would be convenient if case reporting by the countries were standardized with all countries reporting the same information at relatively the same time to the Pan American Health Organization. In the degree to which it is available, this information allows all the countries in the Region to be knowledgeable about the dengue situation as well as the nature of the circulating viruses.

The information that should be reported would include:

- Probable cases of dengue fever
- Confirmed cases of dengue fever
- Cases of dengue hemorrhagic fever
- Deaths attributed to dengue hemorrhagic fever
- Serotypes identified.

Due to the epidemic nature of the disease, the frequency with which this information should be reported is weekly. PAHO, in turn, would have the information available upon request, as well as for reporting to other Member States (through its country offices) on a monthly basis.

4. Current Status of Dengue Vaccine Development

The development of a safe, efficacious and inexpensive dengue vaccine will contribute to dengue control efforts, particularly in developing countries. This has been the goal of scientific groups and specialized agencies, including WHO and the U.S. National Institutes of Health.

Several technological approaches are being tested in the development of dengue as well as other flavivirus vaccines: attenuated, inactivated and sub-unit vaccines, infectious clone-derived vaccines, antigen vectored systems, and nucleic acid vaccines. Presently there are four vaccines in the early stages of clinical trials (Phase 1: Safety and Immunogenicity).

5. Building Effective Dengue Programs

Strong and viable dengue prevention and control programs should include the following components:

- Firm political and financial support with effective intersectoral coordination;
- Selective vector control with an effective social communications program based on behavioral change and community participation;
- Active dengue surveillance based on a strong health information system;
- Emergency mode of action and preparedness for outbreaks and epidemics;
- Training and capacity-building at all levels; and
- Vector control research.

Some of the key elements that programs usually do not possess, or, if they do, need to be strengthened are:

- Epidemiological and entomological surveillance;
- Clearly defined and realistic goals and targets that have measurable indicators;
- Evaluation tools that periodically measure the effectiveness of the vector control interventions that are implemented;
- Behavioral change strategies in dengue prevention and control;
- Patient care within and outside the formal health sector, including disease diagnosis recognition and proper response (including initial care in the home and knowledge of basic treatment measures);
- Adequate political leadership, particularly in epidemic situations;
- Provisions for social science research focusing on behavior change;
- Proper emergency preparedness and response; and
- Awareness of the economic impact of the program's various prevention and control components.

6. Pan American Health Organization Technical Cooperation

At present, the focus of PAHO's technical cooperation efforts is:

- Community participation based on behavioral change;
- Establishing indicators for social behavior;
- Development of innovative techniques in vector control incorporating community participation;
- Techniques for introducing educational programs in dengue control;
- Increase in inter-divisional collaboration (with HEP–Health-in-Housing)
- Interaction with Ecoclubs (youth movement in Latin America focusing on health and the environment, recycling, and community mobilization) directed towards source reduction and health education;
- Training of health workers at all levels; and
- Social advocacy.

In its work to date with Member States, PAHO has mobilized human and financial resources at various levels, including:

- Recruitment of a social communicator to develop strategies in community participation;
- Active pursuit of multisectorial cooperation to focus on dengue;
- Identification of potential extra-budgetary sources to support these new strategies; and
- Strengthened interactions with PAHO/WHO collaborating centers, particularly in the area of social communication.

7. Removing the Dengue Threat

The numerous health benefits accrued through implementation of a strong dengue prevention and control program make it imperative for countries to revisit this issue. It is also necessary to address existing vulnerabilities in their national dengue programs taking into account the availability of PAHO technical expertise and the Secretariat's willingness to work with the countries however best feasible.

OPERATIONAL DEFINITION OF DENGUE, DENGUE HEMORRHAGIC FEVER, DENGUE SHOCK SYNDROME CASES, AND CASE REPORTING

As previously stated, it is important to standardize case reporting in the Region. By doing so, all Member States will be able to be maintained informed of the situation of the disease at all times.

To achieve this goal, there should be agreement for definitions as well as what should be reported and when it should be reported. Definitions as published in the *Epidemiological Bulletin* Vol. 21, No. 2, 2000 are as follows:

Clinical Case of Dengue Fever

A clinical case of dengue fever is defined as being an acute febrile illness of 2-7 day duration with two or more of the following signs or symptoms:

- Headache
- Retro-orbital pain
- Myalgia
- Arthralgia
- Rash
- Hemorrhagic manifestations, and
- Leucopenia.

Laboratory Criteria for Diagnosis

Laboratory criteria for diagnosis is defined as one or more of the following:

- Isolation of the dengue virus from serum, plasma, leukocytes, or autopsy samples.
- Demonstration of a four-fold or greater change in reciprocal IgG or IgM antibody titers to one or more dengue virus antigens in paired serum samples.
- Demonstration of dengue virus antigen in autopsy tissue by immunochemistry or immunofluorescence or in serum samples by EIA.
- Detection of viral genomic sequences in autopsy tissue, serum, or CSF samples by polymerase chain reaction (PCR).

Case Classification

Suspected case:

Any case compatible with the clinical description for dengue.

Probable case:

A case compatible with the clinical description with one or more of the following:

- Supportive serology (reciprocal hemagglutination-inhibition antibody titer greater than 1280, comparable IgG EIA titer or positive IgM antibody test in late acute or convalescent-phase serum specimen).
- Occurrence at same location and time as other confirmed cases of dengue fever.

Confirmed case:

A case compatible with the clinical description, laboratory-confirmed.

Criteria for Dengue Hemorrhagic Fever/Dengue Shock Syndrome

Dengue hemorrhagic fever is defined as a probable or confirmed case of dengue and hemorrhagic tendencies evidenced by one or more of the following:

- Positive tourniquet test
- Petechiae, ecchymoses, or purpura
- Bleeding: mucosa, gastrointestinal tract, injection sites, or other
- Haematemesis or melaena
 - and** thrombocytopenia ($< 100,000$ platelets per mm^3)
 - and** evidence of plasma leakage due to increased vascular permeability, manifested by one or more of the following:
 - more than 20% rise in average hematocrit for age and sex
 - more than 20% drop in hematocrit following volume replacement treatment compared to baseline
 - signs of plasma leakage (pleural effusion, ascites, hypoproteinemia).

Dengue Shock Syndrome

This is defined as having all the above criteria, plus evidence of circulatory failure manifested by rapid and weak pulse, and narrow pulse pressure (less than 20 mm Hg) or hypotension for age; cold, clammy skin; and altered mental status.