

**Strengthening Implementation of
the Global Strategy for
Dengue Fever/ Dengue Haemorrhagic Fever
Prevention and Control**

Report of the Informal Consultation

18-20 October 1999

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**World Health Organization
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Parasitic Diseases and Vector Control**

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Executive summary

Dengue fever and dengue haemorrhagic fever are becoming increasingly important public health problems in the tropics and sub-tropics. Exacerbated by urbanisation, increasing population movement, and lifestyles that contribute to the proliferation of man-made larval habitats of the mosquito vector, the worsening epidemiological trends appear likely to continue. The situation warranted an urgent review of the Global Strategy, the available tools and the partners, and to learn from and consider how relevant advances among other health and development, communications and commercial sector programmes can be applied to dengue.

The Informal Consultation on Strengthening Implementation of the Global Strategy on Dengue Fever/Dengue Haemorrhagic Fever Prevention and Control was held in Geneva from 18 to 20 October 1999. It brought together specialists and scientists with public health expertise in dengue and other related disciplines including epidemiology, clinical management, vector control, behaviour change, the Integrated Management of Childhood Illness, public-commercial sector partnerships, non-government organisations and other disease control programmes.

Developed in 1995, the Global Strategy for Prevention and Control of Dengue Fever and Dengue Haemorrhagic Fever comprises of five major components: selective integrated vector control, with community and intersectoral participation; active disease surveillance based on a strong health information system; emergency preparedness, capacity building and training; and vector control research (*Report of the Consultation on: Key Issues in Dengue Vector Control Toward the Operationalization of a Global Strategy, WHO, Geneva, 6-10 June 1995, CTD/FIL(DEN)/IC/96.1*).

In reviewing the Global Strategy, this consultation focused on three fundamental aspects: surveillance for planning and response; reducing the disease burden; and changing behaviours. The need to strengthen and standardise disease reporting systems was highlighted, using standard case definitions for dengue fever and dengue haemorrhagic fever. The utilisation of information for more effective programme planning was also seen as a critical area for improvement. It was further recommended that indicators of “behaviour change” be developed for incorporation into surveillance activities by national programmes, along with epidemiological and entomological surveillance. The proposed incorporation of this third facet to surveillance has proven successful in HIV prevention programmes, and in dengue is intended to monitor the development of participatory approaches to vector control and to management of illness.

Under the ambit of “reducing the disease burden”, it was concluded that there is sufficient evidence on the reduction of dengue haemorrhagic fever case fatality rates through application of standardised clinical management practices to warrant an acceleration of capacity building and training in this field, with a view to reducing case fatality rates to less than 1%. In addition to delivery of patient care in government health facilities, there is a large but unquantified proportion of patients who receive treatment at home or from private providers. Hence, better understanding of disease recognition and initial care in the home and of treatment seeking behaviour and quality of care in the informal as well as the formal health care systems were also deemed

essential. Here, tools and approaches developed within the Integrated Management of Childhood Illness framework for improved quality of care in the home and by private providers can be applied to dengue.

The application of vector control methods, including source reduction, use of chemical larvicides and adulticides and of biological control agents is hindered by weak programme capacity, the absence of well-defined indicators and programme targets, and poor understanding of efficacy and cost-effectiveness of control measures particularly in terms of reducing transmission. A better understanding of virus transmission dynamics and the identification of transmission thresholds was seen as one of the major epidemiological and operational research challenges.

The third aspect under consideration was “behaviour change”. Dengue prevention and control programmes, particularly those with a strong social participation component, frequently adopt educational approaches, working on the premise that knowledge leads to behaviour change. However, experiences in some other public health programmes, including in HIV prevention and diarrhoeal diseases prevention and control, have demonstrated that there is poor correlation between knowledge and behaviour change. Hence, in such programmes emphasis has shifted to the development of behaviour change interventions. Their adaptation, development and application to dengue prevention and control were urged by the group.

Finally, there is a growing recognition that between them, ministries of public health and “communities”, in the traditional and restricted geographic sense of the word, need to develop strong links with other key partners for a sustainable reduction in the risk of infection and burden of disease. Again, there are precedents within other disease control programmes of partnerships within the public sector, and between the public and commercial sectors, which can meet both enterprise and public health objectives.

Introductory remarks

Dr David Heymann, Executive Director of the Communicable Diseases Cluster (CDS), opened the meeting and drew attention to the fact that while global and regional strategies for prevention and control of dengue fever and dengue haemorrhagic fever (DHF) have been in place for several years, the burden of disease continues to increase. He noted that in 1998 case reporting reached unprecedented levels. In his view, the growing political awareness of the disease and the recent incorporation of aspects of dengue prevention and control in all three departments of the cluster made the convening of the meeting a timely one.

Referring to the broad spectrum of expertise among the participants, from public health disciplines both directly and indirectly involved in the field of dengue, he expressed the hope that the interactions and guidance of the group would provide further direction and additional momentum to the international collective effort to combat this disease. While research offers the future promise of additional control tools, including a dengue vaccine, Dr Heymann stressed the need to take a pragmatic approach in response to the immediate and urgent needs of affected countries.

Dr Heymann concluded his introductory remarks by expressing appreciation to the US Agency for International Development for assistance in planning the meeting and financing the attendance of several participants.

Background and purpose of the consultation

Earlier public health gains from highly successful programmes to control the urban vector of yellow fever and dengue fever, not least in the Region of the Americas, have largely proven unsustainable. With the exception of very few countries, dengue fever and DHF today remain even more impressively uncontrolled despite high levels of expenditure by governments in many endemic countries. Indeed, 1997/1998 witnessed a global pandemic unsurpassed in scale and severity and the value for money of current investment in and approaches to dengue vector control are being called into question. As we enter the new millennium, without an available and effective vaccine, more large-scale epidemics can be anticipated and the worsening epidemiological trend appears set to continue.

Against this background, the consultation sought to identify priorities for action that will contribute to more effective implementation of available measures to reduce the burden of disease attributable to dengue infection and to consider promising new approaches. Hence the objectives of the meeting were to:

- Re-examine the Global Strategy in the light of recent experiences and to recommend, if appropriate, any adjustments.

- Identify key activities that will contribute to reduction of the disease burden, particularly with respect to reducing case fatality rates and reducing or interrupting transmission.
- Discuss the technical and methodological limitations of the tools currently available for dengue prevention and control and to identify priorities for their improvement or replacement.
- Identify opportunities for drawing on the experiences of other behaviour change initiatives.

Global status of dengue and dengue haemorrhagic fever

The global prevalence of dengue has grown dramatically in recent decades. Dengue fever and DHF/dengue shock syndrome (DSS) occur in over 100 countries and territories and threaten the health of more than 2.5 billion people in urban, peri-urban and rural areas of the tropics and subtropics. The disease is endemic in Africa, the Americas, The Eastern Mediterranean, South-East Asia and the Western Pacific. Although the major disease burden is in South-East Asia and the Western Pacific, rising trends are also reflected in increased reporting of dengue fever and DHF cases in the Americas. Prior to 1970 only nine countries in the world had experienced DHF epidemics; by 1995 the number had increased more than four-fold. In the 1950s an average of 908 DHF cases per year (the majority of which were DHF) were reported to WHO. For the period 1990-1998 this average had increased to 514,139 cases. In 1998, a total of 1.2 million cases of dengue and DHF were reported to WHO including 3442 deaths.

Globally, the annual number of infections is much higher than is indicated by the number of reported cases. Based on statistical modelling methods there are an estimated 51 million infections each year.

Overview of the Global Strategy

The Global Strategy for prevention and control of dengue fever DHF, enunciated in 1995 (Report of the Consultation on: Key Issues in Dengue Vector Control Toward the Operationalization of a Global Strategy, CTD/FIL(DEN)/IC/96.1), comprises of five major elements (i) *selective integrated vector control, with community and intersectoral participation*, in which control is directed towards geographic areas of highest risk of transmission, integrating all appropriate methods in the most cost effective and economic manner; (ii) *active disease surveillance based on a strong health information system*, involving clinical and laboratory-based dengue surveillance for early detection of epidemics and vector surveillance for monitoring and evaluation of control programmes; (iii) *emergency preparedness*, necessitating development of emergency and contingency plans, including education of the medical community, hospitalization plans, case management and emergency vector control; (iv) *capacity building and training*, in surveillance, laboratory diagnosis, case management and vector control at

professional, supervisory, technical and field levels; and (v) *vector control research* including studies on vector biology and control, disease relationships, design and management of control programmes, including social and economic approaches, and cost-benefit analyses.

From an operational perspective, the strategy does not include the identification of clearly defined and realistic goals and targets with measurable indicators. Also, the weak evidence base on effectiveness of the available vector control measures, as well as the underlying issues of behaviour change, which are common to prevention and control, patient care within and outside the formal health care services and political practice, are areas warranting particular attention within the framework of the strategy.

Dengue and the Tropical Disease Research Programme (TDR)

Inclusion of dengue within the disease portfolio of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) was formally ratified by the Joint Coordinating Board in June 1999. Identification of TDR priorities for research on dengue are in progress and workplans will be finalised in early 2000. In late May 1999, an ad hoc scientific working group considered the research gaps and developed an initial list of topics from which research priorities could be drawn. They were categorised in five broad areas:

Social, Economic and Behavioural Research

- Analyse cost-benefit and cost-effectiveness of the vector control strategies
- Evaluate social and economic impact
- Identify social, environmental and economic determinants of disease risk
- Identify appropriate/effective behaviour to be promoted in the communities
- Develop effective community-based information, education and communication surveillance systems

Vector Research

- Improve understanding of vector biology, behaviour and transmission dynamics
- Develop sustainable and effective community-based vector control strategies
- Develop new or improved vector control methods/technologies
- Improve and validate operational tools for vector surveillance, including geographic information systems
- Explore alternative pesticide products for emergency vector control

Diagnosis

- Develop rapid and sensitive antigen detection test
- Develop rapid and specific serological test
- Evaluate available recombinant antigens for serological testing
- Develop easy and safe methods for antigen and genomic characterisation of dengue strains
- Standardise simple polymerase chain reaction techniques for routine use

Pathophysiology

Predicting high risk patients and vaccine interaction in naturally infected individuals:

- Virus phenotype – virulence
- Early markers of infection (CMI)
- Factors involved in plasma leakage and coagulopathy
- Genetic susceptibility to DHF/DSS
- Molecular basis of interference among dengue viruses

Vaccine Discovery and Development

- Definition of a vaccine product profile
- Support further development of live tetravalent vaccines
- Explore and develop new technologies such as: use of infectious clones to construct chimeric viruses; live vectors of dengue virus proteins; subunit vaccines
- Develop animal models

It is to be noted that 25% of the TDR budget is used for research capacity strengthening so that scientists from endemic countries can participate more fully in the research process.

WHO regional perspectives on implementation of the Global Strategy

Region of the Americas

The presentation was based on the document “A blueprint for action for the next generation: dengue prevention and control” (PAHO/HCP/HCT/136/99). This document was developed by PAHO as part of a Regional, consensus-building exercise in 1998 which recognised the importance of behaviour change and gave particular emphasis to the development of sustainable community-based programmes. In the ensuing discussion, there was mention of the need to identify relevant “success stories” which can then be used for advocacy purposes. Also that the priorities of public health programmes are seldom in accordance with individual, household and wider community interests and priorities, and that this should be regarded as an underlying justification for broadening attention from a single disease-based focus to one with greater significance and perceived relevance to the communities concerned. It was suggested that the critical issue is not whether comprehensive, community-based approaches to vector control are appropriate, but that implementation of the measures warrants the development of new strategies.

South-East Asia Region

Countries of the South-East Asia Region are stratified into four categories, (a) those in which epidemics have been caused by all four virus serotypes in the past 20 years, where there is high morbidity in children, epidemics occur in urban centres every 3-5 years, spreading to rural areas, and where multiple virus serotypes are circulating

(Indonesia, Myanmar, Thailand); (b) those in which DHF is an emergent disease, epidemics are becoming more frequent, multiple virus serotypes are circulating and the disease is spreading geographically within countries (Bangladesh, India, Maldives, Sri Lanka); (c) those from which there are no reported cases and endemicity is uncertain (Bhutan, Nepal); and (d) those without epidemic dengue (DPR Korea).

In this region particular emphasis has been given in recent years to capacity building and training in diagnosis and clinical management of dengue fever and DHF. Further studies on the social and economic impact of dengue and DHF were urged.

Western Pacific Region

In this region, where approximately two thirds of reported cases in 1998 were from Viet Nam, the difficulty of applying WHO standard case definitions was recognised, particularly among peripheral health staff. Linked to this difficulty is the combined reporting of dengue fever and DHF cases whereas each should be reported separately. Although regionally there has been an overall decline in reported case fatality rates to below 1% since the early 1990s¹, much higher rates are reported from Cambodia and the Philippines. Decentralization and health sector reform in some countries have been identified as problems when local governments do not receive adequate guidance and support from the national government department of health. This was seen not so much as an issue of financing and publicity but rather one of clarity and direction. In several countries, Healthy Cities/Healthy Schools projects are in place, offering an opportunity for leadership in dengue prevention and control but there was an identified need for reaching consensus on the definition of "healthy cities" and for establishing norms, standards and criteria.

Because of the large proportion of infections that never present at reporting health facilities, the limitations of relying on disease surveillance were noted. Hence it was suggested that efforts should be made to strengthen antigenic and serological surveillance, good laboratory-based active surveillance being especially important during inter-epidemic periods when clinicians may not be suspecting or reporting cases.

Concerns were expressed about emergency vector control, not only in terms of the consistency of technical efficacy, but also of the operational feasibility and timeliness of such measures and the competencies of responsible field staff. In the absence of active, laboratory-based dengue surveillance, the ability of most national programmes to detect epidemics sufficiently early in the epidemic curve to allow for timely deployment of control measures was of particular concern.

¹ Without the adoption by national surveillance systems of standard case definitions for dengue fever and DHF, the accuracy and comparability of reported DHF case fatality rates cannot be assured.

Surveillance for planning and response

A. Epidemiological Surveillance

Few countries have an effective epidemiological surveillance system and the capacity to mount a timely and effective response. More than 50 countries have a passive surveillance system, but active, laboratory-based surveillance needed to predict epidemic dengue/DHF is present in only a few situations, including Malaysia and Singapore. Other dengue-endemic countries in Asia, e.g., Thailand, Indonesia, Viet Nam, Sri Lanka, Myanmar and Maldives have good passive surveillance systems for DHF, but not for dengue, which reflects the bulk of transmission. In the Americas, dengue and DHF are reported separately and DHF case fatality rates can be calculated more accurately than in other regions. The United States, Brazil, Puerto Rico and Cuba all have good laboratory capability for supporting active surveillance, but only Puerto Rico uses this surveillance as an early warning system. In the Pacific only Australia, Tahiti and New Caledonia have good laboratory capability, but this is not used to support active surveillance.

Four major areas were suggested in which surveillance can be improved. (1) Through consistency of reporting standards. The WHO case definitions are not strictly adhered to, and some countries only report DHF while others do not distinguish between cases of dengue fever and DHF. Standardised and clear case definitions for dengue fever and DHF/DSS should be tracked and reported separately. (2) Both passive and active surveillance systems should be in place, with regional reference centres able to provide laboratory backup. (3) The epidemiological information must be refined for more effective use by policy makers and programme managers. Currently the epidemiological surveillance data are frequently incomplete, delayed and not used for decision making purposes. (4) Indicators should be developed so that householders can see for themselves the status of dengue in their communities and any changes that their actions may bring about.

B. Entomological Surveillance

Classical larval indices used in *Aedes* surveillance appear to have limited use in assessing transmission risk and are a poor proxy for measuring adult abundance. Moreover, such traditional house to house larval surveys are labour intensive and are plagued by difficulties of access, particularly in urban settings. The less visible and inaccessible breeding sites, such as roof gutters, wells and other subterranean breeding sites are often overlooked. Of particular importance, however, is their adaptation for use as container-specific larval indices to guide and monitor larval control measures including source reduction efforts.

Techniques have been developed, based on “key containers” and “key premises” which focus on identification of the habitats which generate large numbers of adults and attempt to make most efficient use of available human resources for surveillance and control. However, it is recognised that key containers may differ from one ecological setting to another.

For detecting the presence or absence of *Aedes* larvae and pupae in containers, studies have demonstrated greater efficiency with hand nets than dippers or ladles. In situations where programmes are using copepods for biological control, fine-mesh nets can also be used for their detection. Various types of funnel traps have proven efficient for detecting both mosquito immatures and copepods in wells which otherwise are difficult to sample.

Man-vector contact is a critical parameter which is more closely linked to the risk of dengue transmission. However, adult resting and human biting collections are largely dependent on the skills and diligence of the collector and are expensive and time consuming for routine monitoring. When there is a risk of virus transmission, human biting collections are also considered unethical. There is need for development and standardisation of proxy indicators and promising new collection methods are under development for routine sampling of *Aedes aegypti*, including disposable sticky lures and resting boxes.

Ovitrap have a well-recognised role in detecting the presence of *Ae. aegypti* at low population densities while the use of hay-infusion attractants have increased their utility for monitoring adult population densities. However, standardisation of the oviposition attractant is needed.

C. Tracking Behaviour Change in the Community

Most dengue control programmes conduct surveillance only for the disease and vectors. However, for prevention and control efforts another critical variable is human behaviour as it relates to management of vector larval habitats and to disease recognition and response. Techniques for collecting data on behaviours relevant to disease transmission have been developed, most extensively for understanding and testing interventions for HIV transmission. Similar tools and systems can be developed for dengue, possibly with three strata in mind, at the level of the individual, group and institution. Behaviours can also be categorised into those linked to (a) preventing production of adult dengue vectors; (b) preventing exposure to bites of adult dengue vectors and other mosquitoes; and (c) treatment seeking and patient care.

Significantly, there was agreement that programmes should not focus exclusively on “knowledge” of the disease or its control, but more importantly on the actual behaviour related to source reduction or treatment seeking. Moreover, behaviour of health care providers, politicians, policy makers, the media and the private sector should also be understood and addressed. In addition, it was emphasised that behaviours can change dramatically during times of public health emergencies such as epidemics.

It was proposed that monitoring, assessment and evaluation of behaviours related to dengue should be accorded an importance similar to that of disease or entomological monitoring. Moreover, it was viewed as a process that should have both “top-down” and “bottom-up” elements, i.e. by national governments and by the various community groups involved. There are tools and protocols which can be adapted for dengue, one such being the Behavioural Surveillance Survey developed by AIDSCAP for HIV prevention programmes. Numerous protocols on care-seeking behaviour are available for malaria and other diseases in the Integrated Management of Childhood Illness (IMCI) framework.

Reducing the disease burden

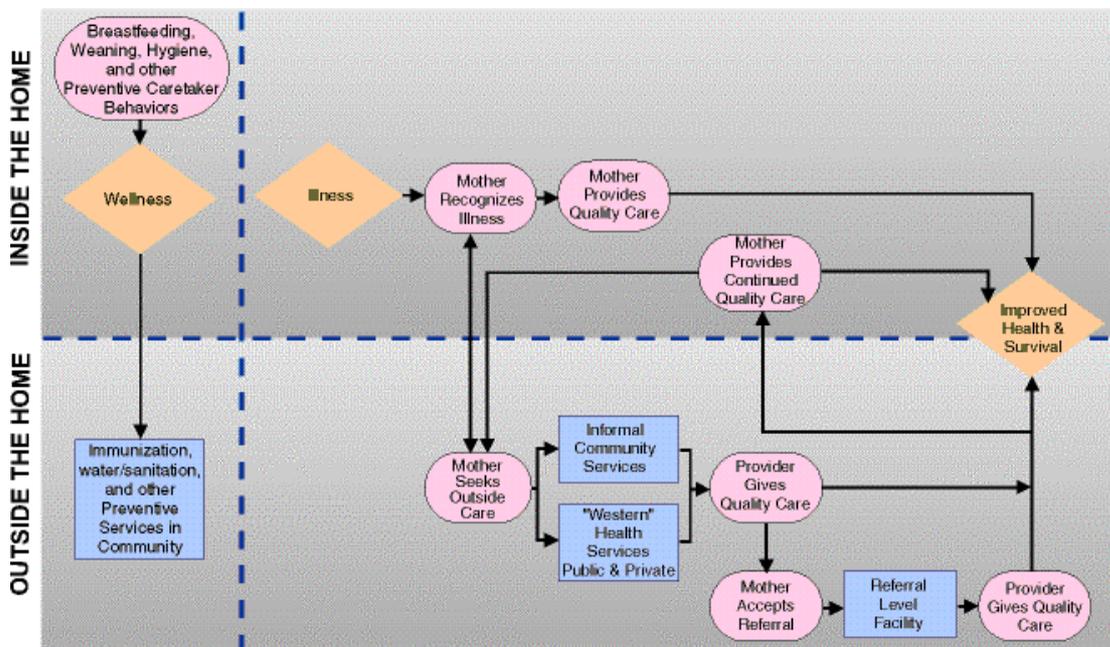
A. Framework for Disease Management

In relating the experiences of Thailand, it was noted that, since the late 1950s, facility-based diagnosis and management of DHF has steadily improved. Protocols, largely developed at the Queen Sirikit National Institute of Child Health, formerly the Bangkok Children's Hospital (designated in 1997 as the WHO Collaborating Centre on Clinical Management of Dengue Haemorrhagic Fever) serve as the standard for training in clinical diagnosis and management. Adequately trained staff, with simple equipment and standard infusion supplies can often bring the DHF case fatality rate to below 1%.

These clinical management guidelines have been incorporated into the IMCI protocols in Indonesia, Viet Nam and the Philippines. However, while the diagnosis and management of DHF in referral-level hospitals has been established and strengthened in Thailand and some other endemic countries, less has been done for disease management in the home and by other providers outside the formal health care system.

A presentation was given on the "Pathway to Survival" framework. This framework has been developed for diseases other than dengue, to analyse the critical steps required for the caretaker to recognise the illness, initially manage the illness in the home, decide to seek care, and to find quality services in either the formal or non-formal health system:

Pathway to Survival



It was proposed that the model be examined to see how it can be adapted and applied to dengue/DHF to provide a comprehensive framework for illness management.

B. Emergency Response

Emergency vector control usually includes measures to rapidly reduce the number of infective mosquitoes over the transmission area. This is undertaken with ultra low volume (ULV) or thermal fog space spray insecticide applications from vehicle-mounted or portable machines and occasionally from aircraft. It was noted that various studies in Asia, and in Latin America and the Caribbean, have reported contrasting efficacy against *Ae. aegypti*. These differences can at least in part be attributable to differences in housing structure, methods of application and insecticide choice and dosage. The impact on dengue transmission is not well understood, largely because of the difficulty of undertaking the requisite and complex studies during epidemics. However, at such times a frequent shortcoming is lack of epidemic preparedness that results in the mounting of operations late in the epidemic curve, with insufficient resources and often with inadequate technical guidance. The extent to which this late response is due to the limited predictive capacity of epidemiological surveillance systems warrants investigation.

Despite these operational shortcomings, and regardless of the fact that emergency space spraying is a costly exercise for which most national programmes are ill-equipped, political pressure to “do something” often overrides any technical considerations. To better assist national programme managers and policy makers in the decision-making process, it was proposed to develop a standard protocol for evaluating the entomological impact of space spraying, which can then be applied to studies commissioned in-country, where efficacy under local conditions can be determined.

Source reduction, larviciding and personal protection measures are also regarded as important elements of an emergency response, with mobilisation of communities through media and other communications channels. However, the timing of such actions was considered even more critical, given that they do not have any impact on existing infected adult populations. Again, the extent to which these interventions affect transmission remains unclear.

Changing Behaviours

A. Lessons from other behaviour change programmes

Behaviour change interventions are central to dengue control programmes, but to date, most programmes have focused on just “knowledge” rather than the “practice” or behaviour change itself. Studies of diarrhoea, dehydration and the use of oral rehydration solution (ORS) in a number of settings show that there is no direct association between an increase in knowledge levels about the benefits of ORS and actual ORS usage rates. In some contexts, as knowledge rates rose, usage rates fell, in others it stayed the same and in yet others, knowledge increased, but disproportionately to the rise in usage rates.

It was suggested that factors influencing behaviour can be categorised into five levels, all of which need to be addressed within a comprehensive behaviour change approach. They are at the level of the individual, the household, the community, institutions, and at the level of policy making and regulation. This behaviour change orientation requires a new relationship with communities and institutions that goes beyond the provision of information for knowledge gain. It was suggested that programmes must look, from the audience’s perspective, at the benefits and barriers to ideal and actual behaviours and attempt to define interventions that reduce the barriers and highlight perceived benefits of healthy behaviours. Such comprehensive approaches to behaviour change may be easier for modifying existing behaviours to produce clearly evident benefits than proscriptive approaches that encourage completely new actions for reasons or benefits that are not at all clear or are of no perceived importance to the audience.

B. Building Partnerships

Building partnerships was considered fundamental to efficient and sustained dengue control. Within the public sector, WHO and national dengue programme managers were urged to show leadership in forging partnerships among the public health ministries, municipal health departments, ministries of the environment, justice and education. Strategic partnerships with the media, the communities themselves and the private sector were also considered to be of critical importance. Examples of such partnerships from other disease control programmes show how the private and commercial sector can be engaged in an extension of public health policy. These include initiatives for improving the reach and sustainability of products such as ORS, soap, contraceptives, reproductive health services, and insecticide-treated mosquito nets. For dengue prevention and control, there appears to be a potential for commercial sector partnerships, including in the areas of solid waste recycling and source reduction, biological and chemical larvicides, and certain household pesticide products such as coils, vapourisers and domestic insecticide aerosols. One of the necessary changes is to expand the public health definition of “community” to include the shop keeper and supporting commercial network. A second important area of partnership involves techniques for improving the quality of care by health care providers in both the public and private sectors; examples from India and Indonesia were noted. The commercial

and private sectors are an important force that can be mobilised to meet mutual “business” and “public health” interests.

There is a recognition within the public sector of the critical importance of intersectoral co-ordinating committees and the leadership role expected of the municipality. NGOs, private and commercial partners and the media can play key roles. In some situations there may be potential for private pest control agencies and ‘mosquito abatement districts’.

Recommendations

A. Surveillance for Planning and Response

- Epidemiological and entomological surveillance need further refinement and strengthening. Most importantly, case definitions and reporting should be standardised, with separate tracking of dengue fever and DHF/DSS. Such reporting will enable more accurate calculation and tracking of DHF case fatality rates. Secondly, entomological indicators need to be refined or developed in order to better reflect transmission potential. They should also provide clear, meaningful information for communities as well as for programme managers and policy makers.
- The ability of national programmes to respond to epidemics in a timely manner should be examined with a view to improving indicators and surveillance systems to ensure that the information is relevant and available for decision making purposes.
- The Global Strategy should be adjusted to reflect the importance of understanding key behaviours and monitoring change. Indicators and systems for such monitoring should be developed and can be monitored with the same scientific rigour as epidemiological and entomological surveillance. This is a relatively new field for dengue control programmes, requiring the adaptation of tools from other behaviour change interventions, e.g., HIV prevention programmes, and from formative research.
- There is need for continued development of simple, affordable and rapid diagnostic tests and of simple standardised methods for characterising dengue strains
- Mathematical models of dengue transmission should be further assessed and refined and a better understanding of aspects of vector bionomics related to virus transmission should be sought, e.g., longevity and biting habits. A better understanding of vectorial capacity may lead to determination of levels of control necessary to reduce or prevent outbreaks.

B. Reducing the Disease Burden

- WHO should intensify its programme of training and capacity building for standard clinical management of DHF/DSS. Affected countries should calculate DHF case fatality rates based on standard case definitions and seek to reduce those rates to 1% or less.
- Using the “Pathway to Survival” model, programmes should take a more comprehensive view of disease management to include not just improved quality of care in government health facilities, but issues related to caretaker recognition of the disease, initial treatment in the home, treatment seeking outside the home and improved quality of care in private health care facilities.

- Training materials should be developed to facilitate the inclusion of dengue in national IMCI strategies in the more severely affected countries.
- For epidemics, emergency packages should be further developed with a view to minimising the disease burden. This will require improved epidemiological forecasting, more accurate modelling of transmission dynamics and a better understanding of the efficacy of emergency vector control measures. Experiences of other emergency and disaster preparedness programmes can serve to strengthen the planning for emergency management and enhance the capacity of health systems when such crises occur.
- The efficacy and effectiveness of existing personal protection and household mosquito control measures should be studied and new vector control tools developed for both routine and emergency contexts, e.g., insecticide-treated curtains, domestic aerosols, mosquito coils and vapourisers. Also, for many of these insect control products, the potential of commercial sector partnerships for increasing reach and sustainability should be explored.
- Further studies on the social and economic impact of dengue fever and dengue haemorrhagic fever should be undertaken.
- The 'Pathway to Survival' and 'Health Seeking Behaviour Framework' methodologies should be adapted and used for analysis of both preventive measures and actions taken within and outside the home when dealing with the sick child. It is especially important for programme strengthening purposes to improve understanding of caretaker and health provider behaviours during epidemics and inter-epidemic periods.
- Studies should be conducted to improve understanding of the pathophysiology of dengue haemorrhagic fever and to identify predictors of severe disease.

C. Changing Behaviours and Building Partnerships

- A package of tools, approaches and guidelines should be prepared that will assist national programmes in the design and implementation of appropriate behaviour change interventions.
- A systematic approach should be used to improve the reach and sustainability of dengue control programmes, involving the identification and building of partnerships among donors, the public sector, non-governmental organisations and the private and commercial sectors. This includes the strengthening of dengue control activities within existing health, social and economic development programmes such as 'healthy cities' projects. Such an approach should be utilised for the development and implementation of large-scale model projects in each of the severely affected regions.
- A clearer understanding of the burden of dengue disease should be sought and a package of effective mitigation measures prepared that can be used for advocacy among political and commercial leaders and others in non-health sectors such as education and urban planning.

- There should be an examination of factors impeding effective dengue control among decision makers in both the public and commercial sectors.
- A 'clearing house' for exchange of information on dengue research, prevention and control should be established.