Part Four Pure and impure water

Health and disease

FOONG KIN

The role of waterborne diseases in Malaysia

Introduction

Water is one of the essentials for the existence of all living organisms, and early settlements usually proliferated around the various sources of natural water. While water is critical for life and survival, it also poses as a constant threat to human health and wellness because of its role in the transmission and spread of a large group of communicable diseases. Gastro-enteric diseases such as cholera, typhoid fever, dysentery, and other viral diseases such as hepatitis A are major waterborne diseases. In Malaysia as elsewhere, cholera and other diarrhoeal diseases are closely associated with inadequate water supply, improper sewage disposal, poor personal hygiene and unsatisfactory environmental sanitation. It is well known that the important vehicle for the rapid spread of these diseases is contaminated water. Water pollution problems caused by contamination of watercourses with bacteria, parasites and a host of microbial disease vectors is the main contributing factor to the health hazard of waterborne epidemics. Human faeces is the main source of infection. It is well known that cholera outbreaks are related with situations in which the water supply is exposed to the high risk of contamination with human faeces due to unsanitary defecation habits of the people (Bhagwan R. Singh 1972:156; Ismail 1988:399). Unsanitary personal and food habits are largely responsible for the persistence and intensification of epidemics. Typhoid fever, another important waterborne disease is also a result of poor sanitation and standards of personal hygiene as well as contaminated food.

The aquatic environment provides an essential habitat for the mosquito vectors and intermediate hosts of parasites that cause human diseases. Among these diseases, malaria outranks all others in severity and distribution. Vector-borne diseases have always affected humans. Mosquitoes such as the *Anopheles balabacensis balabacensis*, a forest breeder, are the principle vector responsible for transmission of malaria in Sabah, Malaysia (Hii 1984:104). It breeds in small, shady pools in clay soils containing fairly clean seepage or rain water that are stagnant or have a low flow, such as animal footprints

or wallow, wheel ruts along track, or blocked ditches in the forest, in palm oil estates, rubber or coconut plantations, or other shady localities (Scanlon and Sandhinand 1965). The two main mosquito vector species, incriminated in the transmission of dengue fever in Malaysia are *Aedes aegypti* and *Aedes albopictus* (Rudnick 1983). They breed in artificial and natural containers and receptacles which hold clean and clear water. Containers such as earthen jars, flower pots, drums, buckets, bowls, coconut shells and rubber tyres are some of the preferential breeding sites (Cheong 1967; Lee and Cheong 1987:118). Other unusual breeding sites include septic tanks, abandoned housing projects, roof gutters, vacant land and construction sites. The *Culex* mosquito that breeds in stagnant drain water is responsible for the transmission of Japanese Encephalitis, another vector-borne disease in Malaysia. Filariasis (*Wuchereria bancrofti*) is spread by particular species of *Anopheles* and *Culex* mosquitoes, whilst *Brugia Malayi* is transmitted by the *Mansonia* mosquito (Ministry of Health 2000:69). Thus, water plays an indirect role in the transmission of these diseases because it enables the breeding of varying species of disease bearing mosquitoes. Human exposure to these vectors increases the risk of contracting these diseases. In Malaysia, there is a significantly higher incidence of malaria and dengue fever compared to the other vector-borne diseases.

This paper provides a description of the prevalence of waterborne (diarrhoeal) diseases and water-related diseases (such as malaria and dengue fever) in Malaysia and factors influencing their spread as well as measures that were taken to prevent and control them. A brief historical account of the emergence of these diseases in the last century and the efforts undertaken to curtail them during the colonial period is also presented. Strategies and actions taken by the Malaysian government in the early part of the twentieth century and post Independence in 1957 are described.

Prevalence of waterborne diseases in Malaysia

Waterborne diseases such as cholera, typhoid fever and dysentery were major public health problems in Malaysia for a great part of the last century. Most of these diseases remain endemic although in the last two decades the incidences of some of these diseases have declined significantly (Ministry of Health 1999a). These diseases were not notifiable until a new Prevention and Control of Infectious Diseases Bill was passed in 1988. In the same year, a Communicable Disease Control Information System was established where information was channeled from operational areas to higher managerial levels for programme planning (Ministry of Health 1989:86). Prior to 1988, statistics on all communicable diseases were available from all hospitals throughout the country. It would be of particular interest to examine a few of these diseases in greater detail.

Cholera, is the most devastating and rapidly fatal of diarrhea diseases. The disease has been in existence in India since time immemorial. The Ganges delta has been often termed as the 'home of cholera'. The world has experienced seven pandemics of cholera and Malaysia has had its share of the epidemics (Chen 1970; Sandosham 1964; Yadav 1981). In the nineteenth century, cholera spread throughout the world, carried along the trade routes by sea and by land. It is noted that in 1817, the disease spread to Malaya, Java and Borneo. The earliest known records of the disease appeared in the 1823-1830 records of the Durian Daun Hospital in Malacca (Sandosham 1964) and in the writings of Innes (1885) who lived in a remote village in Langat, Selangor (Bhagwan R. Singh 1972:149; Yadav and Chai 1990). In the Straits Settlements (1826-1867), cholera was noted as 'a scourge in the crowded poorer quarters' on Penang Island (Turnbull 1972:210). The disease was endemic in the Straits towns Penang, Malacca and Singapore. Several outbreaks of the disease due to the classical *Vibrio cholerae*, were recorded in the nineteenth and the early twentieth century (1910-1915, 1918-1920, 1924-1927) in Malaya (Bhagwan R. Singh 1972:150). It was 'spread partly from the notoriously over-crowded ships which brought pilgrims from Mecca' (Turnbull 1972:218). Pilgrim trade together with an open immigration policy facilitated the importation of waterborne diseases such as cholera. A well known cause of the disease was the 'pollution of water arising from the filth and bad drainage in the Strait town, and this was appreciated at the time, even though the exact nature and cause of cholera were not known' (Turnbull 1972:219). The public expressed the need to improve drainage facilities, but the colonial government at that time lacked the resources to finance such schemes. It was only towards the end of the nineteenth century that the construction and improvement of waterworks in the main townships enhanced health conditions and eventually freed the towns of the scourge of cholera (Chai 1967:202).

In the first half of the twentieth century, suspected cases of cholera that were reported were few, usually notified when a ship arrived at a Malayan port. Other overland infections have occurred via Siam and Kedah (a northern state in Peninsular Malaysia) and also by illegal immigrants when they landed surreptitiously on the coast in small vessels (Institute for Medical Research 1955).

The spread of *Vibrio cholerae* biotype El Tor, from the island of Sulawesi (Celebes) to Malaya was reported in the early sixties, both in the states of Sarawak, in East Malaysia and Malacca in Peninsular Malaysia. It was believed to be due to the shifting of the Chinese population and to troop movements. The epidemic was restricted to the coastal areas, often affecting poor fishermen and their families, who lived under unsanitary conditions. Infections were carried up rivers. The outbreak of cholera in Malacca in 1963 was brought in by sea route from Sarawak. Movement of army and police personnel between Malaya and these territories during the Brunei rebellion was one of the main factors. Another

cause was the severe drought (affecting water supply) that mainly affected the coastal and riverine communities (Bhagwan R. Singh 1972:157; Yadav 1981). Mortality rate in outbreaks from 1900 to 1946 was very high (ranging from 60 to 80 percent). It declined to zero to 30 percent in 1961 to 1970. This partly due to improved medical facilities and treatment, and partly perhaps to the fact that *Vibrio cholerae* biotype El Tor is less virulent than the classical *Vibrio cholerae*.

In addition to contaminated freshwater, marine water is another source of cholera infection. *Vibrio cholerae* has been found to harbour in marine plankton and in molluscs and in fish skin and intestines (Epstein, Ford and Colwell 1993). Vessels that move from one port to another could be a good carrier of the *Vibrio cholerae*. This explains the spread of the disease across continents.

Statistics for the years 1970 to 1997, showed that there were major cholera outbreaks in 1974, 1978, 1983, 1990 and 1995. Outbreaks had occurred in several states such as Sarawak (Yadav and Chai 1990); Kelantan (Abdul Rahman Isa et al. 1990); Perak (Gan 1981); Kedah (Chen 1970) and Malacca (Sandosham 1964). There is a fluctuating peak every five years. A declining trend in cholera has been observed over the last ten years. Outbreaks of cholera in Peninsular Malaysia have been associated with river pollution from human excreta and the fact that river water is usually the source of water supply for all purposes in the rural home (Chen 1970:255). Outbreaks have tended to occur in the dry season (May, June and July) when many are forced to use river water. The disease is prevalent amongst people living in the rural and suburban areas and is associated with ignorance, poverty, insanitary water supply, and sewage disposal, bad personal hygiene and poor environmental sanitation (Bhagwan R. Singh 1972:157).

For the first few decades of the last century dysentery, next to malaria, was the leading infectious disease in Malaysia. The period between 1911-1921 saw more than 47,000 deaths from dysentery in a population of about a quarter million in the part of Malaysia then known as the Federated Malay States (Perak, Selangor, Pahang, and Negeri Sembilan). The number of cases treated in government hospitals between 1900-1930 for dysentery alone, came to 38,444. The number of deaths among these was 11,420 (Ow-Yang 1971:1). Improvement in sanitary conditions of the people has led to a significant decrease in dysentery cases post 1930. From 1981 to 1985, the incidence rate of dysentery cases per hundred thousand population was significantly higher than that for cholera Ministry of Health (1986:43). An overall decline has been indicated in the last two decades.

Typhoid fever was the leading waterborne disease in most years from 1976 to 1998 with a significantly higher incidence rate per hundred thousand population compared to the other waterborne diseases. However, a decreasing trend has been indicated from 1986 to 1997. This disease is endemic in all states and the years 1986, 1987 and 1991 had high incidence rates and deaths (Ambu

2000:499; Ministry of Health 1999a). Outbreaks in local areas were a result of consumption of contaminated water (Soong 1971:28) and food (Narinderpal Singh and Menon 1975:9). Other contributing factors include delay in diagnosis, emergence of antibiotic-resistant strains, problems in identification and management of carriers and the lack of availability of a safe, effective and cheap vaccine. Increase in regional movement of large numbers of migrants is another important factor (Merican 1997:299).

Prevention and control of waterborne diseases

Prevention and control of waterborne diseases such as cholera and typhoid could be achieved through improvement of clean water supply and education regarding personal cleanliness and hygiene. Epidemiological monitoring, investigation of outbreaks and disease pattern, and identifying effective measures are important strategies for control. Systematic approach to control began in the late sixties, with the launching of a pilot rural environmental sanitation programme in 1968 (Ministry of Health 1982:94). This was a response to a survey in eleven selected rural areas in all eleven states in Peninsular Malaysia, that found only 3.6% of the population were supplied with piped water; 85.3% obtained their water from unprotected wells and 11.1% used untreated surface water, for example, streams, rivers, ditches, etcetera. Eleven pilot projects were implemented in West Malaysia. The programme provided clean water supply, built sanitary toilets, encouraged proper disposal of rubbish and sullage waters as well as improvement of cleanliness of the village environments. Programme activities involved community effort and participation, health education, transfer of appropriate technology together with human resource training. In these early years of control, the World Health Organization provided expert advice and recommended various strategies to the Malaysian government. They included the formation of a National Committee for Diarrhoeal Disease Control, use of oral rehydration salt therapy, operational research and setting up of laboratory facilities.

A long term Rural Environmental Sanitation Programme was launched in 1973. It embodies the special task of rectifying problems arising from insaniary water supply, improper sullage water, excreta and refuse disposal and personal hygiene. The programme aimed at reducing the incidence of communicable diseases associated with poor sanitation and this can be achieved by installing proper sanitation facilities. Various strategies have been implemented to achieve the programme target: 1. Encouraging the rural population to adopt good sanitary practices through health education; 2. To ensure full acceptance by the community and optimum results of the programme, actions have been taken to involve the community in the preparation, construction, installation and organization of activities under this programme; 3. To pro-

mote the construction and usage of sanitary facilities such as sanitary water supply system which supply clean, sufficient and easily available water and construction of it at the least cost, installation of sanitary latrines to ensure safe excreta disposal practice and sullage drains and proper refuse disposal to create a clean environment; 4. To identify areas which are affected by outbreaks of cholera, diarrhoeal and other water-related diseases and prioritize them in installing sanitary facilities; and 5. To encourage the participation of state government agencies and voluntary organizations in the programme (Ministry of Health 1985:97). By 1994, 83.5% of the rural households were supplied with proper piped water (Ministry of Health 1995:66).

In addition to improving the quality of drinking water through proper piped and chlorination of water and environmental sanitation, mass vaccination have been implemented during epidemics to prevent further spread of cholera. Oral rehydration salt therapy, the most advanced in the treatment of cholera, was introduced nationwide since 1983.

Decreases in water contamination, improvements in waste disposal, and antibiotic therapy have contributed to the control of infectious diseases such as cholera and typhoid in Malaysia. Incidence of these diseases has been reduced substantially. There is a general decline in trend of the major waterborne diseases, with the exception of the five to seven year trend of cholera epidemics. In recent years, most communicable diseases are more food borne as opposed to waterborne (Ministry of Health 1994). However, there is a constant threat of imported cases that may carry new strains of pathogens, as a result of the increasing influx of migrants into the country in recent years. This necessitates a review of current control strategies to place more emphasis on vigilance, detailed case investigation and prompt appropriate and efficient case treatment and management to prevent and control such diseases.

Water-related vector-borne diseases

Malaria

Malaria remains an endemic disease of public health importance in Malaysia. The disease was first reported in Penang, the first British settlement in the early nineteenth century. Malaria had claimed many lives of the immigrant Europeans (Institute for Medical Research 1955). The disease has been reported to spread like 'wild fire in the rubber plantations' during the colonial days (Chai 1967:202). The town areas remained feverfree, but in the 1840s, when Europeans began moving to live on the outskirts of town and convicts were sent to fill in swamps and construct roads in the country, reports of intermittent fevers were high (Turnbull 1972:211).

In Malayan history, malaria has been disastrous to the unprepared community making its first contact with the disease. The early settlers in Penang,

the first planters in the hillcountry, the workers in the first rubber plantations, the ill-fated community of European administrators were some examples. Intensive agricultural activities, unusual combinations of tide and rainfall, development of roads and other such activities that are favourable for vector breeding have caused malaria cases to rise in large numbers.

Prior to 1965, malaria cases recorded were only reflective of trends in areas served by the hospitals, such as plantations, mines, and areas around the town. Incidence of malaria of the rural communities was unknown. The first systematic blood film survey was conducted in 1965 in Peninsular Malaysia. Based on this malaria survey, together with the confirmed malaria cases in hospitals, and the prevalence of malaria among the aborigines, a projected estimate of incidence indicated over three hundred thousand malaria cases per year (Jit Singh and Tham 2005). In the state of Sabah it was estimated that over two hundred and fifty thousand cases occurred in 1955 in a population of 400 thousand.

Malaria control in Malaya began with the work of Watson, a district surgeon, in 1901. Watson was in charge of the Klang, Kuala Langat and Kuala Selangor districts on the coast of the Strait of Malacca. At the time Klang was surrounded by a large area of swamp, year after year for the previous five years the population had been swept by waves of malaria. The death rate of its inhabitants was 160 per thousand. In November 1901, there was an epidemic of malaria of exceptional severity. Watson decided that the only way to control the disease was to control the mosquitoes. He decided to drain the swamps around Klang. The result was spectacular. The epidemic was controlled within a short time. A similar episode happened in Port Swettenham, lying on the estuary of the Hang River. A great majority of government servants and labourers who were brought in to work at the port were stricken with fever. Watson's strategy of drainage was applied and the number of malaria dropped (Watson 1921). Watson's method of clearing the jungle to remove shade and the draining of water collections were applicable to all districts under similar conditions. By 1910 most of the main towns situated on the lowlands of the Federated Malay States were reasonably malaria free. However, this method of drainage for flat land when applied in hilly areas was found to lead to an increase in malaria case because the drainage methods created an ideal condition for the hilly land mosquito vector (*Anopheles maculatus*) to breed. This problem led Watson to experiment with subsoil pipe drains. In 1911 the first subsoil pipe drains were laid in a rubber estate and proved to work well.

A Malaria Advisory Board was formed in 1911 to cope with the increasingly serious malaria problem and was given a free hand, with wide powers to advise and coordinate as well as to order and execute control measures. Watson's subsoil drainage and oiling are still the basis of urban malaria control and may be expected to remain so. Synthetic insecticides were later used

instead of larvicides, because they were cheaper. By 1940 a few of the most malarious estates, where oiling had never been very satisfactory, had adopted mepacrine prophylaxis following the demonstration of its effectiveness (Jit Singh and Tham 2000:13). Residual insecticides were not used extensively until about 1951 when, owing to the emergency, the resettlement of large numbers of people in new villages created an immediate need for malaria control. House spraying began to be used as an alternative to suppressive drugs. Before the Second World War, with the exception of rubber estates, there was no malaria control in the rural areas other than the free distribution of quinine by traveling dispensaries, village headmen, police and post offices. Malaria control was not possible in these areas before the advent of DDT (Jit Singh and Tham 2000:13).

An eradication programme was launched in Peninsular Malaysia in 1967. Spraying of DDT emulsion and case detection and treatment reduced the reported cases of malaria from three hundred to four hundred thousand annually prior 1967 to ten thousand in 1978 and 1979. In the East Malaysian state of Sarawak, the eradication project which started in 1961, succeeded in reducing reported malaria cases from a level of forty to fifty thousand per year in a population of one million to about 1,500 in 1970 and 1971. Malaria control activities started with DDT spraying and mass drug administration in 1958. In 1968 only 11,517 cases were reported. However, between 1974 and 1981, the incidence of malaria in Sabah had reached epidemic proportions (Branding-Bennett 1981; Jit Singh 1985).

The original strategy of malaria eradication was changed to that of malaria control in both Peninsular and East Malaysia (Sabah and Sarawak) in 1980. This was a result of the persistence of factors that demanded a new strategy of control. Deforestation for purposes of land development, road and dam construction increased breeding sites for the malaria vector, *Anopheles maculatus*. Forest clearing for agriculture was cited by Lim (1992) as creating malarial habitats. Population movements of specific populations such as the Orang Asli (aborigines), security forces in and out of jungle areas, movements of people across international borders are contributing factors to increases in malaria cases because of exposure of these people to bites of infected mosquitoes. The increasing incidence of chloroquine-resistant *Plasmodium falciparum* malaria is another factor.

Geographical, occupational and educational factors were found to influence transmission and control of malaria among the Murut of Sabah. Living in remote rural areas and being involved in forest-related occupations were likely to magnify exposure bites of infected mosquitoes and thus malaria (Foong 2000:90). These communities also had inadequate access to modern information on malaria, information that could alter beliefs and attitudes about diagnosis, treatment and personal protection against malaria and about vector

control. Remote rural areas were characterized by traditional beliefs, often associated with lower level of education, and by poor accessibility to modern health services. While some taboos (refusal to have houses sprayed or provide blood specimen for malaria diagnosis) remain as barriers to malaria control in these communities, some traditional practices have value and provide protection from malaria. For example, constructing houses on stilts which reduce mosquito accessibility into homes, rearing of animals near homes for *Anopheles* that prefer animals to humans, and the use of traditional herbs such as *Eurycoma longifolia* (local name is *tongkat ali*) which has antimalarial properties.

The Malaria Eradication Programme was replaced by the Vector-Borne Disease Control Programme in 1986. The objectives of this programme are to reduce the morbidity and mortality of malaria to a level that it does not constitute a major public health problem in the country, and to prevent the recurrence of malaria in non-malarious areas. The major anti-malaria activities include passive and active case detection, mass drug administration for purposes of chemoprophylaxis among high risk populations, case investigation, DDT residual spraying, focal spraying, health education and entomological activities. Currently the spraying of houses with deltamethrin is the main strategy of vector control. Focal spraying is carried out in land schemes, logging camps and in Orang Asli communities in the interior. The use of insecticide-treated bed nets was introduced in 1993 in the malaria prone areas as well as in areas of outbreak (VBDCP 2000:112).

Indoor residual house spraying, using long-acting insecticides, still remains an important strategy in the control of malaria especially in the highly malarious areas. Several factors influence the effectiveness of DDT residual spraying. Incomplete coverage is an important factor. Inaccessibility to remote interior areas is another constraint. There is also public resistance to spraying because of the dislike of the DDT wettable powder that sticks to walls of homes and also poses as a health hazard. In recent years, deltamethrin is also used in addition to DDT (VBDCP 2000:109).

The number of malaria cases detected annually has been on the decline since the 1980s. In 1988, the incidence rate per ten thousand population was 30.3 (or 50,721 cases) and this has declined to 6.1 by 1998 (VBDCP 1990:22, 2000:20). Since 1998 there has been an increase in the number of imported cases. There is also an emergence of malaria in urban areas. For example in 1999, five outbreaks were recorded in urban non-malarious areas such as in housing projects and urban areas that were being developed (VBDCP 2000:27). The people affected were foreign workers (mainly Indonesians) who worked at the construction sites and they were imported cases.

Although there is an overall decline in cases in the country and in most states, malaria remains a major problem in the state of Sabah. Sabah holds the national record by contributing about eighty percent of the malaria cases

in Malaysia since the start of the malaria eradication programme in 1961. In spite of various anti-malaria activities carried out so far to control malaria, it continues to be a scourge in the state as it has been in the past. The standard anti-malaria measures which have been in use for more than a quarter of a century in Sabah, have not been able to stop the resurgence of malaria due to the following reasons: 1. the refractory nature of the main vector *Anopheles balabacensis balabacensis*; 2. the inaccessibility due to lack of communication; 3. nature of terrain; 4. constant population movements; and 5. poor housing conditions. Since effective malaria vaccines remain many years away, the widest scope for reducing malaria in Sabah lies in promoting 'self-protection' measures, in line with the primary health care concept that individuals and communities take greater responsibility for their own health. A special plan of operation was implemented from 1995-1999. Under this programme emphasis was given to enhance early detection and prompt treatment of malaria, particularly at the periphery; providing further support and incentives to primary health care volunteers; creating awareness of the seriousness of malaria; promoting the use of insecticide-treated bed nets; improving epidemiological data collection; improving and strengthening management and supervision and enhancing national and international training capabilities (Ministry of Health 1999b:196-205). With the implementation of the Plan of Operation, malaria cases have declined dramatically by 88%, from 49,865 cases in 1995 to 6,099 cases in 1998. The incidence rate had declined from 279 in 1995 to 22 per ten thousand population in 1998.

The Vector Borne Disease Control Programme is now fully integrated with other control programmes such as tuberculosis, leprosy, AIDS/STD to form the Communicable Disease Control Programme. This facilitates early case-detection, treatment, case investigation, case follow-up and other control measures at the first point of contact.

Dengue fever

Dengue is a febrile viral infection that, in its more serious forms, can cause haemorrhagic fever and shock syndrome. The earliest report of dengue fever in Malaysia was from Penang in 1902. However, the first report of dengue fever with haemorrhagic manifestations was made only in 1962 in Penang Island (George 1987:278). Since then, the disease has become endemic throughout the country. In 1973, there was a major outbreak of dengue haemorrhagic fever. Subsequently, in 1974, a plan of action for the prevention and control of dengue fever and dengue haemorrhagic fever was put into immediate effect and the disease was made notifiable.

The disease is endemic and occurs throughout the country with maximum number of cases reported during the months of July, August and September. The incidence rate of dengue from 1973 to 1991, ranges from a low of 2.4 per

hundred thousand population to a high of 36.4 in 1991 (Satwant Singh 2001:6). Control was successful in maintaining the incidence rate to less than 10.0 per hundred thousand population for most of the years. However, from 1996, an upward trend in incidence rates was observed, the highest in the last three decades. The incidence rates rose from 67.3 in 1996 to 89.7 in 1997 and 123.4 in 1998. This was a result of rapid urbanization and population (both local and foreign) growth in the cities, a different life style (such as throwing of non-bio-degradable containers), rapid transportation and poor living conditions (poor water supply in squatter areas). All these gave rise to an increase in breeding habitats for the *Aedes* mosquitoes and thus the easy spread of the virus.

There was a drop in incidence rate per hundred thousand population from 123.4 in 1998 to 43.8 per hundred thousand population in 1999. One of the reasons for this drop was the successful implementation of the National Cleanliness and Anti Mosquito Campaign launched in April 1999. The campaign aimed at increasing awareness among all citizens on the cleanliness at home, workplace and surroundings and its relationship to mosquito borne diseases (Ministry of Health 2000:62).

The strategies used in the control of dengue fever are: 1. epidemiological surveillance through prompt case notification through telephone followed by written notification, case investigation and follow-up; 2. laboratory diagnosis through the use of rapid screening tests and confirmation by standard laboratory technique; 3. improved clinical management through case detection and institution and supportive management of care in hospital; 4. vector control through source reduction, done by search and destroy activities, anti-adult operation through chemical fogging, and legislation; 5. interagency collaboration and co-operation for control of dengue in specific population sub-groups and high risk areas such as schools and construction sites; 6. health education activities including community participation through community involvement in activities related to dengue control (Satwant Singh 2001:2).

Control of dengue remains a great challenge in the future. New initiatives such as reprioritization of areas and targets under *Aedes* surveillance, mass-abating, sequential fogging, use of synthetic pyrethroids, personal protection, increase in enforcement activities, improvement in health education and greater community/inter-agency involvement are given the emphasis.

Conclusion

Waterborne and water-related vector-borne diseases such as malaria and dengue fever remain endemic in Malaysia and persist as important public health problems and major cause of mortality and morbidity. Concerted preventive and control efforts of the Malaysian government in the last four decades have reduced these health hazards substantially through wider dis-

tribution of safe drinking water and improvement of environmental sanitation. Scientific advances in development of techniques for testing and treating water with disinfectants (chlorination) have a great impact on prevention of waterborne diseases such as typhoid, cholera and dysentery. Availability of vaccination for diseases such as cholera and typhoid as well as oral rehydration salt therapy for cholera helped to reduce potential suffering and loss of lives caused by such diseases. While the above efforts were major contributing factors in reducing the prevalence and incidence of these diseases, improved nutrition is also an important factor that led to a reduction of their impact. There is a need to sustain and further improve control efforts especially to certain localities that continue to have poor access to adequate water supply and poor sanitation. Malaria continues to be a threat to certain populations and control measures such as DDT spraying and chemoprophylaxis do not have a significant impact on further reducing incidence of the disease. Current efforts should aim more at reducing suffering through rapid diagnosis and treatment of cases. The resurgence of dengue fever in recent years points to the need to sustain surveillance and improve control efforts. Close epidemiological surveillance is required to monitor the incidence and distribution of both waterborne and water-related vector-borne diseases in Malaysia in view of the changing environmental and human ecological impact on health.

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