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Eliminating Dengue Fever should be Easy Compared to Malaria – In a Malaysian Perspective

A. M. Meer Ahmad[1*] and Chew Aik Koay[2]

[1]Meer Ahmad Health Consultancy, A317 Apt Selasih, Jln PJU 10/1C, Damansara Damai, 47380 Petaling Jay, Selangor, Malaysia.
[2]Innotech Resources, Kelana Jaya, 47301 Petaling Jaya, Selangor, Malaysia.

Authors' contributions

This article was written in collaboration between both authors. Author CAK, a entomologist' had written on new tools and strategy in the prevention and control of dengue in Malaysia including Larvicide-application, space spraying (Ultra low volume, ULV or thermal fogging), attractant toxic sugar baiting and attractive lethal oviposition trap beside recent trend in these. Author AMMA, Public Health Consultant, designed the study, had written the protocol, had written the remainder of the article and the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Introduction: In 1993, the International Task Force for Disease Eradication thought over and concluded that only six diseases are eradicable – but, malaria, dengue fever (and, dengue hemorrhagic fever) were not included.

In 2010, 99 countries reported 219 million cases of malaria and 660,000 deaths. In Malaysia in 2011, 5152 cases had been reported causing not more than 30 deaths.

Over 2.5 billion are at risk of dengue fever given the endemicity in excess of 100 countries, compared to nine countries in 1970. The WHO estimate 50-100 million cases annually globally, with approximately 500,000 dengue haemorrhagic fever, and an estimated 22,000 death each year. In Malaysia in 2017, there is found 83,849 reported cases of dengue fever with 177 deaths.

There is a compelling need to give thought here to an elimination/eradication programme on dengue fever in Malaysia, realizing there is presently a malaria-elimination programme already.

**Corresponding author: E-mail: meerahmadmeera@gmail.com;*

Aim: The Aim of this Review is to contemplate on the priority of possible public-health intervention of infectious-diseases, the International Task Force on Disease Eradication, and the three principle/indicators toward successful eradication/elimination programme, and the cost, beside describing the epidemiology and eradication/elimination of malaria in Malaysia, including the human and economic cost of malaria, in a comparison with dengue fever, including the dengue control & prevention programme and the potential in the innovative-methods, and why a dengue fever elimination programme is timely and imperative.
Methodology: This article is a Narrative Review, and the author focus the article around three articles published by the author in recent times on dengue fever, and two on malaria. Additionally, the author contemplate around relevant newer article by various author retrieved through PubMed and Google Search.
Results: Based on priority of possible public-health intervention of infectious-diseases by the International Task Force on Disease Eradication, and the principle/indicator(s) identified by the Task Force, and the Dahlem Conference, toward successful eradication/elimination programme, and the World Health Assembly on dengue fever, it is felt that a dengue fever elimination programme is timely and imperative, beside found very cost-beneficial.
Conclusion: Mankind can eliminate dengue fever, even if not actually eradicating the disease, in a very much feasible and cost-beneficial programme, beginning in every nation and every region of the world, prior to grouping to become a global-programme.

Keywords: Eradication; elimination; malaria; dengue fever; diagnostic-tool; International Task Force on Disease Eradication; Dahlem Conference; cost-benefit; transmission chain.

1. INTRODUCTION

Smallpox has now been eradicated and many a programme have presently begun to eradicate poliomyelitis and dracunculiasis (guinea-worm disease). In 1993, the International Task Force for Disease Eradication thought over 80 potential infectious-disease and concluded that only six were eradicable – but, malaria, dengue fever (and dengue hemorrhagic fever) were not included [1,2].

Although here malaria, yellow fever, and yaws eradication-programme of many a past year were not successful, these did contribute in a tremendous manner to an improved-understanding of the biological, social, political, and economic complexity of achieving the ultimate-goal in disease-control [1,2], but Malaysia did manage to eradicated yaw and practically eradicated malaria.

In 1997, the WHO also listed leprosy, onchocerciasis, and Chaga's disease as candidate toward elimination 'as public-health problems' within ten years [1,2]. Malaysia has practically eradicated leprosy, and the latter two diseases are not found in Malaysia. Again here, malaria and dengue fever are found included not.

The Dahlem Conference (Workshop) talked on the priority of possible public-health intervention in dealing with infectious-diseases, which were defined as [1,2]:

1. Control,
2. Elimination of disease,
3. Elimination of infections,
4. Eradication, and
5. Extinction

Eradication has been defined in various ways [1,2]:

a. As the extinction of the disease pathogen,
b. As elimination of the occurrence of a given disease, even in the absence of all preventive-measures,
c. As control of an infection to the extent that transmission ceased within a specified area, and
d. As reduction of the worldwide rate (incidence) of a disease to zero as a result of deliberate-effort, obviating the need in the cessation of any more control-measures

Thus, by definition c., malaria is practically eradicated /eliminated in Malaysia, especially in Peninsular Malaysia where not more than a total of 100 cases is found among the 4 – 5 states, out of 11, where the disease is still seen on the Peninsula [2].

Further definitions are [1]:

Control: The reduction of disease incidence, prevalence, morbidity or mortality to a locally acceptable-level as a result of deliberate-effort - continued intervention-measure is required to maintain the reduction. Example: Diarrhoeal diseases.

Elimination of disease: Reduction to zero of the incidence in a defined geographical-area as a result of deliberate-effort - continued intervention-measure is required. Also, defined as an annual case-rate of <1 each million population Example: neonatal tetanus.

Elimination of infections: Reduction to zero of the incidence of infection in a defined geographical-area as a result of deliberate-effort - continued intervention-measures to prevent re-establishment of transmission is required. Example: measles, poliomyelitis.

Eradication: Permanent reduction to zero of the worldwide-incidence of infection caused by a specific agent as a result of deliberate-effort – intervention-measures, not any longer required. Example: smallpox.

Extinction: The specific infectious-agent not any longer exists in nature or in the laboratory. Example: none.

As is obvious here, there is not a great difference between elimination and eradication as is found defined. Disease-eradication programmes had been generally conceived as global-programmes and past-programmes had been put to work as such. But conceptually, eradication and elimination can be attempted, perhaps initially, at national level and/or regionally.

Disease eradication and elimination programmes are conceptually simple, focusing on one clear and unequivocal outcome. But at the same time, the implementation is extraordinarily difficult in the reason of the unique global operational-challenges and time-driven operational-challenges. The limitations, potential-risks, and areas-of-caution for eradication and elimination programmes include bigger short-term cost, increased risk-of-failure and the consequences of failure and the need toward urgency, beside diversion of attention and resources from equally or additionally important health-problems that are not eradicable, or even such as those may be eradicable [1,2].

1. Eradication-programmes and current-programmes are complementary approaches to public-health [1,2].
2. Elimination and eradication are the ultimate goals of public health, evolving naturally from disease control [1,2].
3. The basic question is whether these goals are to be achieved in the present or some future generation. Deadlines toward achievement need to be set [1,2].

A dengue elimination-programme can very well be made to ride the current malaria-elimination programme.

Care must be taken that eradication and elimination effort do not detract or undermine the development of the general-health infrastructure. Additional limitations include the great vulnerability of eradication and elimination programmes to interruption by war and civil-disturbances; the potential that programmes will not address national-priorities in every country, and that some will not follow the eradication/elimination strategy; the perception of programmes as ‘donor-driven’; placement of excessive, counter-productive pressure and demand upon health-work and such; and the requirement of special-attention in many a country with inadequate-resource and/or weak health-infrastructure [1,2].

The favourable-attributes and potential-benefit of eradication/elimination programmes are a well-defined scope with a clear objective and endpoint, and the duration is found to remain defined and limited. Any successful eradication/elimination programme produces sustainable improvement in health and provides a high cost-benefit ratio. Eradication/elimination programmes are attractive to potential monetary-source in the reason that these establish high-standards of performance for surveillance, logistics, and administrative-support; groom well-trained and well-motivated health-staff; assist in the development of health-services infrastructure including, for example, mobilization of the endemic-community; and provide equity in providing to all affected-areas, including urban, rural, and even remote rural-areas. These also offer opportunity in various additional health-benefits (e.g. for dracunculiasis eradication: Health-education and improved water-supply), improved coordination among the partner and the various country, and dialogue at the frontiers during war [1,2].

All that is decide on initiating a global disease-eradication/elimination campaign should also bring to think the ideal sequencing of potentially-concurrent campaigns. Eradication/elimination programmes consume major human and financial-resource. Careful thought need to be given whether two or more eradication/elimination programmes are to be conducted simultaneously or sequentially, or whether the target-disease is confined to a limited geographical-area [1,2].

Disease elimination and eradication programmes can be distinguished from current health or disease control-programmes by the urgency in the elimination and eradication programmes beside the requirement in targeted-surveillance, rapid-response capability, high-standards of performance, and a dedicated focal-point at the national-level. Eradication/elimination-programmes and current-programmes need to be seen as potentially complementary-approaches in public-health. There is found areas of potential overlap, conflict and synergy that must be recognized and addressed. In many cases, the problem is not that eradication/elimination activity function too well but that primary health-care activity do not function well enough. Effort is needed to identify and characterize many such as factors responsible toward improved-functioning of the eradication/elimination programme [1,2].

Three indicators are considered to be primarily important [1,2]:

a. An effective-intervention is available to interrupt transmission of the agent and the effectiveness of an intervention-tool has both biological and operational dimensions.
b. Practical diagnostic-tools with acceptable sensitivity and specificity are available, including to detect the level-of-infection that could lead to transmission. Such diagnostic-tools also have both biological and operational dimensions. The tool must detect infection that could lead to transmission, and also found sufficiently simple to be applied widely enough (globally) by laboratories having a wide-range of capability and resource.
c. The important need, on a priority, that humans are a part of the life-cycle of the agent, which has no other vertebrate reservoir and does not amplify in the environment. Eradication/elimination is a much more feasible target of deliberate intervention when humans form an essential component of the agent's life-cycle. An independent-reservoir is not an absolute-barrier to eradication/elimination if it could be targeted with many a effective intervention-tool.

In the reason that the health-resource is limited, there is a need to decide whether the use in a elimination/eradication programme is preferable to the use in various different areas [1,2].

The cost and benefit of eradication/elimination programmes concern [1,2]:

a. Every direct effect on morbidity and mortality, and
b. The consequent-effects on the health-care system.

The success of any disease eradication/elimination-initiative depends:

a. Strongly on the societal and political commitment level, with
b. A key role for the World Health Assembly in the case of global-eradication attempt.

Thus, it is clear that both malaria and dengue fever are amenable to eradication/elimination programmes either conducted at the same time in one and the same programme or with separate programmes – if not involving in global-programmes, then to start with national or regional programmes that could subsequently coalesce to become global-programmes.

The Aim of this Review is to contemplate on the priority of possible public-health intervention of infectious-diseases, the International Task Force on Disease Eradication, and the three principle/indicators toward successful eradication/elimination programme, and the cost, beside describing the epidemiology and eradication/elimination of malaria in Malaysia, including the human and economic cost of malaria, in a comparison with dengue fever, including the dengue control and prevention programme and the potential in the innovative-methods, and why a dengue fever elimination programme is timely and imperative.

2. METHODOLOGY

This article is a Narrative Review, and the authors focus the article around three articles

published by the authors in recent times on dengue fever, and two on malaria. Additionally, the authors contemplate around relevant newer articles by various authors retrieved through PubMed and Google Search.

2.1 Malaysia – Background

Malaysia, a equatorial country has land-border with Thailand, Brunei, and Indonesia. Annual-monsoons blow in the southwest from April to October, and a pronounced-monsoon in the northeast from October to February [2-4].

There is found three general part of the country: Peninsular Malaysia, comprising 11 states; the Sabah and Sarawak States on the island of Borneo; and three-areas in a federal-territory - Labuan, Kuala Lumpur, and Putra Jay. The area is one of a 329 847 square-kilometer, and comprise much of coastal-plain that rise to undulating hill-land and mountain [2-4].

The population approximated 29 million in 2011. Malaysia is a upper middle-income country which had a GDP per capita of 16 900 ($ USD) in 2012 with a 4.4% real growth-rate [2-4].

There is found several ethnic-group - Malay (50.4%), from China (23.7%), indigenous peoples (11.0%), Indian (7.1%), beside unspecified-ethnicities (7.8%) [2-4].

Malaysia had been administered first by the British in the early 20th century and then by the Japanese during World War II from 1942–1945. After the Japanese occupation, the country had again been administered by the British, till independence in 1957 [2-4].

The country is a strong multi-sector economy, aiming for high-income status by 2020 in a New Economic Model (NEM). It is working to attract biotechnology and high-technology companies, beside investment from many a company abroad [2-4].

The health-system is found universally to provide health-care free-of-charge and support a robust private-sector and health-tourism industry. The Health Ministry guides on health-policy, besides running central health-programmes [2-4].

Primary health-care is provided at the district and sub-district level, with secondary and specialty care delivered in the many a public state-hospital, teaching-hospital, and private-hospital. Malaria-control work is paid toward and put to work by the government. Health-programmes do not receive outside funding from multi or bilateral organizations [2-4].

In 2010, the country had a total of 131 public-hospital with 33 211 available-bed beside doctor-ratio and nurse-ratio of 1.17 and 2.45 respectively per 1000 population [2-4].

The health status of the population has shown dramatic improvement from the 1980s. There is presently seen the usual epidemiological shift of middle and upper-income countries, moving from a high communicable-disease burden to a bigger non-communicable disease burden [2-4].

In 2010, the commonest notifiable-diseases are found dengue fever, tuberculosis, hand foot and mouth disease, food poisoning, and HIV. Malaria became a notifiable-disease since the Global MEP in 1967. Failure to notify under the Prevention and Control of Infectious Disease Act of 1988 became punishable by law. In the same manner, dengue fever from the time of the Act [2-4].

The infant mortality rate (IMR) in 2011 is six per 1000 live-birth, much lower than the East Asia and the Pacific Region entirely, where the IMR is found 42 per 1000 live-birth. The Expanded Programme on Immunization (EPI) vaccination-achievement remained between 95% and 98% - a strong indication that the country's universal health-care delivery service is effective. Malaysia is found at 61st in the International Human Development Indicator (HDI) list [2-4].

2.2 Malaria and Malaria Eradication/ Elimination in Malaysia

The Malaria Control Programme, that had initially been a vertical programme, became part of the Vector-Borne Disease Control Program (VBDCP) in the mid-1980s. The scope of the national-level Malaria Control Programme, within the VBDCP, is that here of developing policy and providing technical-expertise in the state and district-level malaria-programmes. The VBDCP, which comprise of epidemiologist, entomologist, and support-staff, is found coordinating policy and supervising the vector-control activity. Each state and district has a own VBDCP, with the provision of staff-time based on the area-rate (incidence) of each vector-borne disease [2-4].

In 2011, *Plasmodium vivax* (2 422 cases, 45.6%) and *P. falciparum* (973 cases, 18.3%) accounted

the majority, closely followed by *P. malariae* (903 cases, 17.0%) and *P. knowlesi* (854 cases, 16.1%), that in total represent most of the cases in Sabah and Sarawak. But in 1992, *P. falciparum* had made up 65.1% of cases, with *P. vivax* 31.6%. A decline in *P. falciparum* cases from 1997 to 2011 is seen - both in number and in proportion. Such a trend is also seen in many a pre-elimination and elimination country. *P. vivax* infection is frequently difficult to detect than *P. falciparum*, - due to lower parasite-load, frequent subclinical-infections, and the life-cycle of *P. vivax*, including the parasite's ability to lay dormant in a hypno-zoitic liver-phase [2,4-9].

P. knowlesi cases are reported from the time 2008, in high-proportion to the total. It is unclear if this is due to improved diagnostic-techniques, or whether cases are rising due to increasing movement over to simian-areas [2,4-9].

An abundance of malaria-transmitting vector-species is found. The vectors in West Malaysia are *An. maculatus, epiroticus, campestris, letifer, dirus, sundaicus and cracens*. The vectors in Sabah are *An. balabacensis, sundaicus and flavirostris*, with *An. latens, donaldi and sundaicus* found in Sarawak [2,4-9].

The principle-vector in West Malaysia, *An. maculatus*, breeds in slow-moving streams and springs in undulating hilly or mountainous areas. The specie is mostly exophagic, or outdoor-feeding, and although here cattle (zoophily) is preferred, the specie feed on humans (anthropophily) between 9 p.m. and midnight - both Exo- and endo-phyllic, resting on the inside wall of the house, beside outdoor-surfaces. Sabah's main-vector is *An. balabacensis*, which usually breeds in small pools of muddy-water, and found in forest-fringe areas. The vector is zoophilic and exophagic [2,4-9].

In Sarawak, *An. latens* and *An. donaldi* are the main vectors. *An. latens* is thought here to be simio-anthrophagic, feeding preferentially on humans and several species of monkey and is frequently implicated in *P. knowlesi* infection, which usually infects long-tailed macaques, but can be transmitted to humans. *An. donaldi* is also zoophilic, exophagic and exophilic. Not unlike *An. latens, An. donaldi* prefers stagnant pools at forest-edges [2,4-9].

The first official-cases of malaria became reported in 1805 on the British-island of Penang. The disease crippled the colony - 20 of the 34 civil-servants stationed on Penang between 1805 and 1825 died from malaria. Throughout the 1800s, malaria affected the native, the British-administrator and the imported migrant-labour, especially from China, Nepal, and India. As new land became cleared to allow plantation-crop, estate, and mine, the owner frequently saw work-forces devastated by the disease. With the growing plantation-sector, imported-cases became frequent and contributed to the increasing-rate (incidence) among both the migrant and the native-people [2,3].

The earliest malaria-programme became started in 1901 in the Federated States of Malaya by the British-administration - applying new data obtained from early malaria-research in developing preventative-malaria programmes [2,3].

Many anti-larval project focused on the reduction of the breeding-site through an environmental-modification technique such as draining and oiling of every pool of water. Larval-control remained the basis for malaria-control in over fifty-years, until DDT became found in the late 1950s. As the rubber-plantation sector grew, many a new agricultural-policy, such as government-mandated draining and clearing of vegetation, prevented major malaria-epidemics [2,3].

The Institute for Medical Research became founded in 1899 to conduct health-research, and became an important part in providing research-capacity and programme-support [2,4-9].

A Malaria Advisory Board became founded in 1911 to guide the government ~~on~~ in control-strategy and put to work the malaria-control project. The member included the government-administrator and the health-officer, the estate-health official, the community-member and the engineer. The Board monitored malaria and the epidemics, besides conducting control-activity. The Board reported 312 323 cases in West Malaysia in 1947, and 159 755 in 1963. These cases are both inpatient and outpatient cases, but were not generally confirmed by microscopy – probably under-reported in the reason that case-detection capacity remained limited from the 1940s to the 1960s, and malaria was not a notifiable-disease during such a time [2,4-9].

Total cases estimated in Sabah, Sarawak, Peninsular Malaysia, and Singapore (part of Malaysia from 1963 – 65, and geographically

still) range from 100 000 to 300 000 annually from 1947 till 1963 [2,4-9].

Malaria control and research in Sabah-state, guided by the malaria-officer employed by the British North Borneo Company, focused very much on entomological-survey and vector-control activity, not different from those in West Malaysia [2,4-9].

The Institute for Medical Research (IMR) continued to conduct operational and scientific malaria-research through to the 1940s until Japanese-occupation halted all malaria-control work. During the immediate post-war era, the malaria-programme saw substantial-progress, particularly in the plantation-sector [2,4-9].

2.3 Malaysia's Malaria Eradication Programme (MEP): 1967–1981

Malaysia launched the MEP in 1967, twelve-years after the Global Malaria Eradication Programme (GMEP) launched - internal political-conflict at that time and doubts around an eradication-programme to succeed in the Malaysian-context, had been the reason causing the delay [2,4-9].

The Malaysian malariologist believed Malaysia's perennial-transmission, fueled by the continual clearing of the jungle to serve agriculture, increasing vector-breeding, the many vectors with varying breeding and biting habit, beside the decreasing effectiveness of DDT against outdoor-biting vectors, could prevent success [2,4-9].

A series of feasibility pilot-projects and field-trials of anti-malarial drugs and insecticides carried out by the IMR overcame the doubts [2,4-9].

A Malaria Eradication Pilot Project and Pre-Eradication Survey became conducted in West Malaysia from 1965–1966 in partnership with the WHO. At such a time, the government cited many a reason in pursuing eradication - reducing the negative impact of malaria on educational-performance, change of Government-policy to increase money-spent on malaria-offices in the rural-area, and the social-responsibility to the rural-poor [2,4-9].

The aim of the MEP had been complete eradication by 1982 [2,4-9].

In 1966, the country had an estimated 300 000 cases, but only 44 910 cases in 1977 – the sharp decrease attributable to increased indoor residual-spraying (IRS) achieved with DDT and improvements in case-detection, both active (ACD) and passive (PCD), followed by case-management [2,4-9].

Fig. 1. Indoor residual spraying
Source: Bayer

With a hundred years of malaria-control experience, Malaysia has benefited from a rich history of malaria control. From 1982 to 2004, the control-programme focused on several key-strategy, including vector-control, scale-up of early-detection of cases and ACD, geographic-reconnaissance, surveillance, and a system of energetic monitoring and evaluation. The programme continued entomological-work, besides including surveillance of all receptive-area having breeding-habitat [2,4-9].

Sixty to 70% of total confirmed-cases became detected through passive case detection (PCD) in health facilities in the 1990s and early 2000s. Between one and two million slides had been collected each year since 1991 through ACD, PCD and various surveys. Additional investigations included mass blood-survey and epidemiologic-survey [2,4-9].

The annual blood-examination rate, ABER (Calculated as (number of slides examined/population) x 100. The WHO recommendation in malarious-areas is that the number of slides examined per month should equal at least 1% of the population), fluctuated from 6.2% to 9.9% from 1991 to 2004, while SPR, the slide-positivity rate, (SPR defined as the number of laboratory-confirmed malaria cases per 100 suspected cases examined, provides a second method for estimating temporal changes in malaria incidence), decreased from a high of 2.7 in 1995 to 0.4 in 2004 [2,4-9].

The WHO recommended using an SPR of not more than 5% as a guide to re-orientate from the control-phase to the pre-elimination phase. Nationally, SPR had remained very much stable between 0.2% and 0.5% since 2003 [2,4-9].

In addition, national-policy did mandate that all febrile-cases seeking treatment at all health-facilities be tested malaria, 100% confirmation of cases by microscopy and mandatory-notification of cases. The strategic-plan aimed at elimination received high-level approval at the end of 2010 [2,4-9].

Laboratory-work quality-control is active. Beside microscopy, the country uses PCR, but may need to look at the rapid serological-tests presently available in case these are found of cost-benefit, beside with high sensitivity and specificity [2,4-9].

Vector-control activity during this time focused on IRS using DDT, on larval-control and on geographic-reconnaissance to identify all sprayable-structure – but, surveillance-activity through case-investigation, ACD, passive case-detection, many a mass blood-survey, and developing the case-register became prioritized [2,4-9].

From 1967 to 1975, the MEP spent 50 million US dollars (unadjusted). By 1969, the GMEP became stopped globally. Overreliance on IRS as the main control-strategy, a lack of flexibility in programming to the different country and different culture, insecticide and chloroquine resistance, and reduced monetary-resource became blamed in the failure of the global-programmes. Malaysia continued the MEP till 1982, at which time the country re-oriented toward malaria-control, copying many of the countries in the GMEP [2,4-9].

The only approved vaccine RTS,S, known by the trade name Mosquirix is launched in 2019 in a WHO-led implementation program piloting the vaccine, among children aged not more than 2 years, in three high-malaria countries in Africa (Meer Ahmad AM 2020). The vaccine has a relatively low efficacy at 26 – 50% - thus, the WHO do not recommend the vaccine in infants aged 6 to 12 weeks. It is given in 3 doses between 5 and 9 months of age and the fourth-dose at around 2 years old.

At the start of the national malaria-elimination plan, the Government increased the commitment to malaria-control activity and human-resource. From 2008 to 2010, the Health Ministry budgeted around $USD 23 800 000 annually on malaria-control, and in 2011 increased this to $USD 37 844 710. This dramatic increase reflected the cost of the additional staff and material-resource necessary to achieve the elimination-target, particularly in areas of current transmission in Sabah and Sarawak [2,4-9].

Although the Malaysian MEP did not succeed in eliminating malaria from the country, it nearly and practically did, especially in West Malaysia and did contribute to a substantial decline in cases in Sabah and Sarawak – in West Malaysia, states outside of Selangor, Pahang, Kelantan and Perak (which four states reported a total of 100 cases in 2012) achieved ‘zero’ incidence, not more than the rare imported-cases and monkey-malaria [2,4-9].

A focus on targeting risk-group became active during this time. The Orang Asli (indigenous) population in West Malaysia (who usually inhabit remote-forest and forest-fringe areas) had historically contributed a significant number of cases. In 1995, 6 141 cases became reported in the Orang Asli. Starting in 2003, the Orang Asli became targeted with increased provision of control-activity by the Malaria Control Programme, and by 2005 only 172 cases had been reported [2,4-9].

Mobile-populations in Sarawak also became targeted, beside remote-folk in Sabah. From the time 2010, all migrant-population became targeted, mainly through mass blood-survey on the plantation-sector and the manufacturing-industry. The Malaria Control Programme has continued to prioritize targeted-intervention in this group [2,4-9].

By 1981, the WHO felt that eradication was not feasible, and malaria-control services around the country became integrated, becoming the Vector-Borne Disease Control Programme. The Programmes in Sabah and Sarawak became integrated by 1986. Throughout the 1990s, the official programme-objective centered on reducing mortality and morbidity of vector-borne diseases and preventing the resurgence in the low-endemic area. Malaria-control activity’s monetary-need continued to be fully met by the Government [2,4-9].

Table 1. Reported cases by administrative area, 1972–1979 (*estimate)

Year	Reported cases in West Malaysia	Reported cases in Sarawak	Reported cases in Sabah	Reported total cases
1972	32 141	2 432	19 000*	34 573
1973	17 655	2 154	24 913	44 722
1974	16 640	2 044	26 417	45 101
1975	12 689	1 667	26 496	40 852
1976	14 931	1 402	46 232	62 565
1977	13 808	1 133	22 627	37 568
1978	10 365	1 548	43 027	54 940
1979	10 500	1 086	33 324	44 910

Source: WHO & University of California, San Francisco (2015)

The programme adopted a Primary Health Care Approach in 1990, whereby diagnosis happened at the clinic and hospital rather than relying on staff of the malaria-control programme. SPR reached a high of 2.7 in 1995 from around 1.7 in 1991. In 1995, Sabah experienced an increase of 20 000 cases; SPR in Sabah increased from 5.9 in 1993 to 9.6 and 9.1 in 1994 and 1995 respectively, contributing to the national-trend [2,4-9].

Surveillance is key to improved targeting of malaria control-measure from the 1990s to date - reactive and proactive screening becoming employed, usually through mass blood-survey. Increased mass blood-survey effort and various investigation (epidemiologic-surveys and reactive case-detection activity) contributed to the success in decreasing the rate (incidence), with around 600 000 to 850 000 thousand slides collected and 5 000 to 20 000 cases detected annually [2,4-9].

IRS continued to be the primary vector-control intervention across the country until the implementation of ITNs in 1995. In 1998, the programme transitioned from DDT, which had been a mainstay in over 40 years, to pyrethroid-insecticides for IRS. But, there is a need to look at newer generation organophosphates and carbamates in a cost-beneficial manner. In addition to conducting IRS in high-risk areas, the programme began to carry out focal-spraying at village-level in receptive non-malarious or malaria-prone areas. This happened every six months throughout the 1990s. Data show that from 1997 to 2000 the programme serviced between 31 000 and 70 000 houses with regular IRS [2,4-9].

ITN distribution with re-treatment every six months, which began in 1995, is reported to have been critical to controlling malaria during this period, but studies reveal that treated-nets have no significant advantage over untreated-nets [2,4-10].

Through mapping, the district-level malaria-control officer could track and monitor cases and vector-breeding areas. Some areas of West Malaysia continued to employ the environmental-management technique, specifically through the use of subsoil-drain. Entomological-surveillance remained maintained throughout the country, and also to determine the efficacy of larviciding-activity [2,4-9].

Community-education became initiated during this time and became conducted through door-to-door visit during IRS/ITN activity. The tasked-officer became tasked with imparting knowledge on signs and symptoms of malaria. Malaria-poster and pamphlet became distributed by the Health Promotion Unit, which conducted health-education campaign beside conducting exhibition, all frequently integrated with the remaining vector-borne diseases [2,4-9].

But, there is reason to think that community-education programmes in vector-borne diseases are poorly implemented in Malaysia. In an example, in an online-survey among doctors in which 38 doctors answered, and among a History Club in which 26 answered, this question had been posed: 'In the past 1 year, how many time have you been approached by Health-personnel in providing Community Education/doing Survey on dengue fever?' A total of 59/64 answered 'zero' times.

In 2000, the on-line surveillance-system, eVekpro, became developed. eVekpro contains data on cases, besides data from case-investigation and vector-control activity. In addition, the eNotifikasi on-line notification-system usable by the health-provider became

introduced in 2000, allowing private and public health-facilities to rapidly report all notifiable infectious-diseases, including malaria and dengue fever [2,4-9].

The two on-line systems help district, state, and national offices to track: data collected on index-cases, data from case-investigation and data on malaria-control activity, including IRS and ITN distribution. Such has allowed the national and state Malaria Control Programme to conduct additionally-sophisticated analyses on the epidemiologic-situation at the village (foci), district, state and national level [2,4-9].

These also allow the Programme to track the trend in areas with present transmission and to quickly identify any outbreak. ACD, mass blood-survey, and various epidemiological-survey continued to be prioritized during this time, with over 1 000 cases detected through these method annually between 2005 and 2008. Passive case detection is found to continue to identify the majority of cases, but ACD, or fever-screening, and mass blood-survey are also responsible for detecting a percentage [2,4-9].

An increased number of rural health-centres, beside general-advances in infrastructure that allow the villager increased access to health-care such as the mobile health-clinic, have likely brought about progress. The capacity of the health-system to quickly detect and treat cases has also been crucial - in 2010, a policy came to be requiring all slides in clinics and hospitals to be read within one day. Such has not only made certain that most cases are confirmed prior to treatment but such that patients are treated promptly and with the correct anti-malarial drug [2,4-9].

Finally, in preventing the introduction of drug-resistant malaria, the National Anti-malarial Drug Response Surveillance programme became started in 2003 to monitor drug-efficacy. The programme consist of 18 sentinel-site in highly-endemic areas within seven states. Till 2015, resistance to artemisinin had not been reported [2,4-9].

One Indonesian study (Hashim et al 2018) is found to show that the incidence of malaria is three times bigger in families that keep cattle, sheep, and goats in and around homes. This is possibly due to the vector feeding on such animal and then breeding using the blood, thus greatly increasing the vector-population. This can be prevented by confining such live-stock to barn-feeding mostly, with IRS of the barn, optionally netting-off the live-stock in such a barn. The live-stock could be let out mostly during the dry-season after residually spraying the live-stock [11].

Economic-development in Sabah including land-use change helped decrease the incidence but economic development also brought set-back - documented and undocumented migration continued to increase and presented a considerable risk of malaria-importation. Areas of virgin-forest became very endemic as migrant-work, employed in timber-extraction and plantation-work, created reservoirs of malaria [2,4-9].

A baseline-survey showed low-provision of both IRS (5%) and ITN (9%) in the malarious-district. The programme responded by increasing financial and human resource to vector-control [2,4-9].

Entomologic-surveillance remain a key-strategy in malaria-reduction. The National Malaria Control Programme (NMCP) also added entomological-staff in district malaria-control office in Sabah and Sarawak to improve monitoring of the vector-situation. The entomologist remains responsible toward monitoring the vector-situation in each district [2,4-9].

In Sabah and Sarawak, the district-level entomologist is monitored by a team of entomologist at the state-level, who provide technical-expertise and supervision. The entomologist from the Institute for Medical Research has continued to partner with the NMCP, researching breeding-habitat and vector-behavior [2,4-9].

2.4 The Human and Economic Cost of Malaria

In 2010, 99 countries reported current malaria transmission, causing an estimated 219 million cases and 660,000 deaths, the deaths mostly in young children in Africa [12].

The cost of malaria could be measured in lives lost, in time-spent ill with fever, and in economic-term. Money spent on preventing and treating malaria, the indirect costs of lost wages, time-home from school, and time-spent caring sick-children, add up at the personal-level. In the

public-sector, a large portion of the health-sector budget is spent on malaria control and treatment. And at the macroeconomic-level, a heavy national-burden of malaria dampens economic-development, frequently subtly, but pervasively. All of this effect is recognized and accepted widely, but the magnitude has been poorly documented [13-16].

Many a study of the effect of malaria has frequently been motivated by a desire to understand the cost of the disease to individuals and society, and frequently to justify public-expenditure to diminish the burden. This type of work has only grown to be important, as competition toward resource became ever additionally explicit, both within the spectrum of malaria-activity (research vs. control, prevention vs. treatment) and between malaria and the remaining diseases [13-16]. Antimalarial Drug Resistance also adds to the Burden of Malaria [13-16].

2.5 The Economic Burden of Malaria

It has long been recognized that a malarious-community is an impoverished community [13].

Ronald Ross, 1911 [13]:

The human costs of malaria are high, in lives that are lost and many more that are diminished. The immediate monetary costs of treating and trying to prevent disease are obvious and large, for governments and families. Those costs are far from the whole economic story, though. Malaria's presence has—subtly, and overtly—influenced the nature of economic activities that define levels of development, and ultimately health and wellbeing in the broadest sense. For centuries, malaria's pervasive effects have been recognized, and people have tried to estimate the costs in economic terms.

Ross cited Dr. Bolton, who estimated that hospital-expense and various direct-expense for malaria amounted to 2.6 rupees per capita in the island nation of Mauritius, a total of about one million rupees for the population of about 383,000. This figure excluded the indirect-cost of illness (Najera and Hempel, 1996). Ross also quoted an estimate from Howard that malaria cost “surely not less than $100,000,000 per year” for the United States in 1909 (Najera and Hempel, 1996) [13].

Sinton examined the cost of malaria “nationally, socially and economically” in India in the 1930s, based on a national malaria-survey. He found malaria caused at least one million deaths directly, and at least two million in case the indirect-effect are included, based on between 100 million and 200 million cases, with a case-fatality rate of 1 percent (Najera and Hempel, 1996). He also is among the earliest to explicitly document areas where malaria prevented the expansion of agriculture, with concomitant lost income [13].

Najera and Hempel (1996) observed (13):

The development of health-statistic during the 19th century, the economic-motivation of the European colonial-enterprise, the recognition of malaria as a serious hindrance and the need toward investment in malaria-control, led to the early effort to define the malaria-problem as a burden, measurable first in economic-term, such as lost-productivity, and subsequently including additional general social-values, such as learning-ability and the impact on education.

The macroeconomic effect, include economic losses to nations from lack of investment from aboard, a drain in human-capital, and the various large-scale effect that hamper overall economic-development. The microeconomic-cost most frequently measured includes the direct-expense, to both the government and the individual, of preventing and treating the disease, and the indirect-cost of being sick with malaria [13-16].

Malaria and poverty find a shared-ground. Where the burden of malaria is highest, economic-prosperity is lowest. At present, both are concentrated in tropical and subtropical areas [13-16].

A recent review by Jeffrey Sachs estimated that the average per-capita gross domestic product (GDP) of malaria-endemic countries in 1995, at about $US1,500 (adjusted for purchasing power parity), is roughly one-fifth the average across the non-malarious world [13]. Annual economic-growth in the malarious-country between 1965 and 1990 averaged 0.4% of per-capita GDP, compared with 2.3% in the remainder of the world. Over time, this decrement suggest that malaria could reduce GDP by nearly one-half in the very endemic country [13-16].

Even in case malaria is not thought of as a cause of low-incomes and poor economic-growth, the disease must be thought of at least a legitimate-contributor, and possibly the major-contributor.

Poverty could lead to a heavier burden of malaria, and in turn, malaria could deepen poverty when a lack of money mean an inability to protect oneself or to properly treat malaria. (Sachs and Malaney, 2002). Some of the way in which malaria could hinder economic-development are [13-16]:

2.5.1 Demographic effects

The death of one million children each year in sub-Saharan Africa is found to affect demographic-pattern, directly and indirectly. The direct-effect is obvious. Indirectly, they could cause high-fertility and large family-size. Whether to ensure surviving-offsprings or caretakers of old-age, the relationship between high infant and child mortality, and high-fertility is strong. Many children per family mean fewer resource - including education, and health-care - for each one. Girls frequently are given the lower priority in education, which adds fuel to the high fertility-cycle. Employment-selections are limited for women having many children; poorer health resulting from multiple-pregnancies also reduces women's capacity to work. In time, these conditions lead to high-cost at the national and family level [13-16].

2.5.2 Effects on human capital

Infants and children carry the greatest burden of malaria morbidity and mortality. Survivors may have a lasting-effect on the physical and mental, and thus, economic-potential. The physical and cognitive effect is recognized, but not well-quantified. Children with malaria lose out by missing school. This can mean bigger failure-rate, bigger dropout-rate, and poorer achievement [13-16].

2.5.3 Trade and foreign direct investment

The failure of the malarious-country to attract investment from aboard has, without doubt, had a major influence on economic development. Examples of the problem malaria bring to the investment-project is now known well. The tourist-trade could also be a casualty to endemic-malaria. The disease confines the workforce, which constrains development [13-16].

2.5.4 Microeconomic studies of the effect of malaria

Tallying the apparent-cost of malaria borne-privately by the individual and the individual's family, by various levels of government, and by the various providers of services (e.g., non-governmental organizations of various kinds, organizations financing malaria programs), the immediate-cost of treating or preventing an episode of illness consist of the 'direct' cost - money spent on malaria prevention and treatment, and in consulting a health-provider, buying medicines, and paying toward transportation in the second-cost. The indirect-cost consist loss of income (or productive labor e.g., lost agricultural-production in the reason of an inability to plant or harvest crops) due to illness – besides every period of feeling too sick to work, time-spent caring those who are sick, and time-spent seeking care [13-16].

2.5.5 Total direct and indirect costs

A few researchers have estimated the 'total' cost of malaria. One early study, published in 1966, estimated the total-cost of malaria in Pakistan (Khan, 1966), based on around 4.2 million people experiencing malaria each year, of whom 2.5 million had been assumed to be the workforce. The cost included the direct-cost of treatment for everyone, adding lost-workday (valued at an average daily wage rate) for the workforce. This totaled to 81 million rupees, amounting to about 0.75 percent of GNP [13-16].

Two such study have estimated total household, direct and indirect, cost. In Malawi, the total annual household-cost came estimated at around US$40, which amounted to 7 percent of household-income (Ettling et al., 1994). Total household-costs came estimated at 9-18 percent of annual-income among small-farmers in Kenya, and 7-13 percent in Nigeria (Leighton and Foster, 1993) [13-16].

One multi-country study has attempted an Africa-wide estimate of direct added to indirect cost of malaria based on extrapolation from the study of areas in Burkina Faso, Chad, Congo, and Rwanda. The total reported is US$1,064 million overall, that amount here to US$3.15 per capita and 0.6 percent of total sub-Saharan Africa GDP (in 1987, inflated to 1999 U.S. dollars) (Shepard et al., 1991). Two of the country case-study estimated household added to government-cost (including the direct-cost of treatment, but not prevention; and including indirect mortality-cost). The national-cost per capita had been estimated at US$1.55 in Burkina Faso (Sauerborn et al., 1991), and US$3.87 in Rwanda (Ettling and Shepard, 1991) [13-16].

2.6 Dengue Fever

Dengue is found as the most important mosquito-transmitted viral disease in terms of morbidity and mortality. It is the most prevalent viral mosquito-borne disease, with over 2.5 billion humans at risk of exposure given the endemicity in excess of 100 countries, compared to nine countries in 1970 [17,18].

Dengue fever is a benign, acute febrile-syndrome found mainly in the tropical region. In a small proportion of cases, the virus causes increased vascular-permeability that causes a bleeding-diathesis or disseminated intravascular coagulation (DIVC) termed dengue haemorrhagic fever (DHF) [19]. Also, infants infected at 6 – 12 months of age, and born to mothers previously infected, are at increased risk of severe dengue due to waning-levels of transplacentally-acquired maternal-IgG and thus, immune-enhanced infection [20].

The vectors are *Aedes aegypti*, the principal-vector which breed in and around the house and the building, and the smaller *Aedes albopictus* which breeds outdoor. They are day-biting, whose peak biting-hour is dawn, early morning 2 hours after dawn, several hours prior to dawn and dusk [17,18,20].

Beside various factors, the bite of the *A. aegypti* is more likely to cause severe dengue (DHF and dengue shock syndrome, DSS) [17-19]. Also, *A. albopictus* is not so anthropophilic as *A. aegypti*, and thus is not so efficient an epidemic-vector. Additionally*, A. polynesiensis* and several species of *A. scutellaris* are vectors, but probably not more than in the laboratory-setting. Each of these species has a specific ecology, behavior and geographical-spread [20].

The major source of Aedes-breeding is at the home/buildings and surroundings, the construction site, the solid-waste dump, open-spaces and in the factory in water-holding containers (e.g. old tyres, flowerpots, trash, or water-storage containers) [17,18,20].

Patients are infective in the viremia-period from briefly prior to till the end of the fever-period. The vector is infective in a 8 – 12 day period after the blood-meal and remain infective throughout life [20].

Blood-borne transmission is possible through exposure to infected blood, organ and various tissue [20].

In addition, perinatal-transmission happens with the highest risk to new-borns born to mothers acutely ill at around delivery, with temperature-instability seen some time just like some perinatal-infections [20].

People from non-endemic areas travelling to endemic-areas are at risk of infection and disease. Dengue is the leading cause of febrile illness among travelers to South-Central/South-east Asia, South America and Caribbean [20].

The WHO estimate is that 50-100 million cases of dengue are found annually, with approximately 500,000 of such cases (0.7%) resulting in dengue haemorrhagic-fever (DHF), with an estimated 22,000 death each year, mostly in children. In 20-30% of DHF cases, the patient develops shock, known as the dengue shock syndrome (DSS) [17-19]. Studies in the Philippines and Indonesia reveal that 70 – 80% of dengue infections are asymptomatic [17,18].

But, early detection and access to proper medical care lower the fatality-rate to below 1% [17,18]. There are 4 distinct, but closely-related, serotypes of the virus that cause dengue (DEN1, DEN-2, DEN-3, and DEN-4). Recovery from infection by one is found to provide lifelong-immunity against that specific serotype. But, cross-immunity to the various serotypes after recovery is only partial and temporary. Subsequent infections by different serotypes increase the risk of developing severe dengue [17,18].

In Malaysia, various serotypes steadily begin to predominate in the various year – the present predominant strain being DENV3 replacing DENV1 and DENV2 [17,18]. The prevalence of the individual serotype varies across different geographies, country, region, season and over time [17,18].

In Malaysia, there is a male-preponderance at 57%. The number of cases steadily increases from a moderate among very young children to a peak in the early twenties, prior to steadily falling to a moderate again in the late 40s, and prior to tapering down to a low in the elderly - although the highest rate (incidence) is among the work and school-going age-group [17,18].

The disease is endemic in Malaysia since the 1980s [17-19]. Shepard DS et al. say that in the reason that Malaysia has a passive-surveillance system, the number of dengue cases is under-reported [17,18].

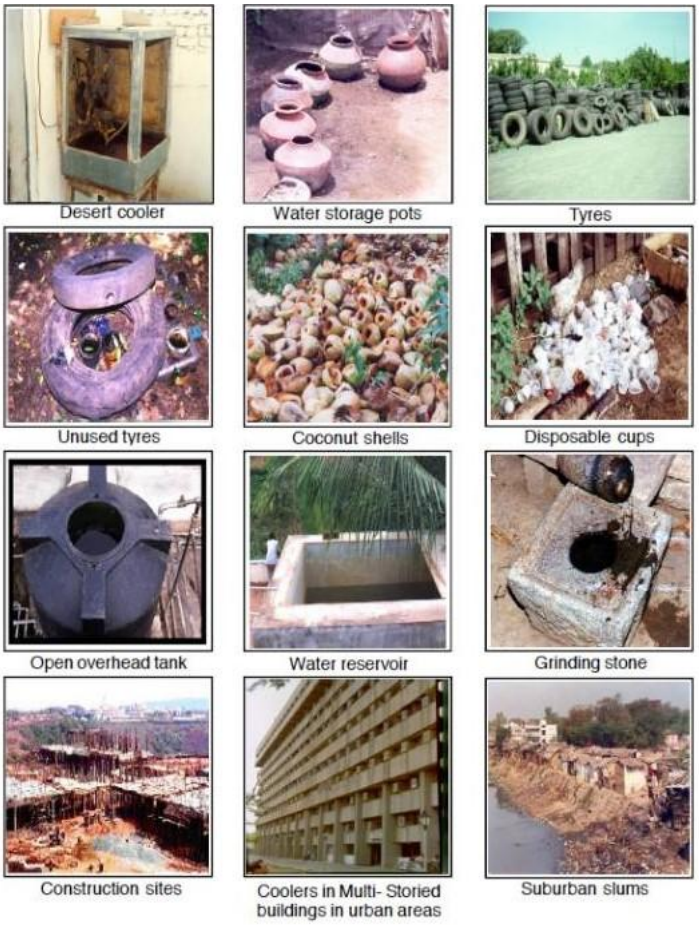

Fig. 2. Common *Aedes aegypti* breeding-site, including in Malaysia

In Malaysia, a “dengue outbreak” is defined as two cases found in an area over 14 days, while a “dengue hotspot” is when the outbreak is sustained in excess of 30 days.

Nur Azila MA et al. in studying 1000 subjects aged 35-74 year old, found 91.6% to be dengue-seropositive. The sero-prevalence increased with every 10-year increase in age. Gender and ethnicity were not factors. There was not any difference between urban and rural areas [17,18].

In 2017, there is found 83,849 reported cases of dengue fever nationwide with 177 deaths, which is a conspicuous reduction from the immediately preceding years [17,18].

The Health Ministry attribute the recent achievement to the integrated effort of the various ministry, agency, society and the individual, although this reduction could be a part of the six-year pattern in the country discussed beneath [17,18].

The National Dengue Task Force (NDTF), which comprises seven ministries and various agencies, became set up in July 2014 to mobilise many a agency and member of the public in dengue-prevention and control-activity [17,18].

Beside the NDTF, there is the National Dengue Committee [17,18]. It is after 2013 that a sharp increase in the incidence had been noted in Malaysia, which has remained sustained [17,18]. The contributing-factor in this sharp increase is thought to be serotype-shift, the mobility of the population, climate-change, human-behaviour, poor environmental-sanitation and ineffectiveness of vector-control activity [17-19].

In the Malaysian context, health-reform in the late-nineties that integrated the vertical organizational-structure of the Vector Borne

Disease Control Programme with the general health-services resulted in loss of technical-expertise beside constraint in monetary-resource, as limited health resource became moved to various competing-programmes under the Ministry of Health which is thought to be the cause of the sharp-increase, coupled with local-government becoming made responsible in some instance. After years of neglect, cities like Greater Kuala Lumpur, Penang, Johore Bahru, Seremban, and Melaka have become hyper-endemic for dengue-transmission, where not just one virus serotype is circulating [17,18].

In the meantime, it is said that the application of many a vector-control method is labour-intensive, requires discipline and diligence, and very hard to sustain [17,18]. In Malaysia, outbreaks of dengue tend to recur in six-year cycles, consisting of a 50 month period with high-numbers of cases followed by two years with relatively low numbers. But, the annual average-incidence of reported dengue-cases in successive six-year cycles has been increasing [17,18].

The economic-burden of dengue-illness in Malaysia was estimated by Shepard et al at US$56 million each year. The researchers state that the estimate could be larger if costs associated with dengue prevention and control, dengue surveillance, and long-term sequelae of dengue were included [17,18].

In estimating the costs of dengue-prevention, Packierisamy PR et al state that the country spent US$73.5 million (0.03% of the GDP) on the National dengue Vector Control Program. The researchers state that where innovative-technologies for dengue-vector control prove effective, and a dengue-vaccine needed to be introduced, substantial existing-spending could be rechanneled to fund these [21].

The study by Halasa and co-work measured the cost, both direct and indirect, of dengue in six categories of cases. The result show the economic-burden of dengue in Puerto Rico to be very high. This study is the first study to show the societal-distribution of the economic-cost of dengue, with the individual-household bearing the largest burden (48%) compared with only 24% by the government and 22% by insurance. The total annual cost of dengue between 2002 and 2010 was $46.45 million ($418 million during the 9 year period) [22].

In a comparison of monetary-cost, the emerging-country that is India had an expenditure of 4.69 billion dollars purchasing power parity (PPP) in direct medical-cost (outpatient /hospital). And, Brazil spent 20.82 million dollars PPP indirect cost of prevention and control of *Aedes aegypti*. France, a developed-country, spent 15 million dollars PPP on direct medical-cost of hospitalization [23].

Two such study brought the analyses of the intangible-cost, represented by the Quality-Adjusted Life Years (QALY). In Panama, there had been found an average of 67% QALY during the worst days of illness in 2005 and in Malaysia, the average had been 60% QALY in 2009 [23].

And, three such study brought indirect cost-analyses, represented by the Disability-Adjusted Life Years (DALYs). In Mexico, the annual disease-rate averaged 65 DALYs each million inhabitant between 2010 and 2011. In Cambodia, the annual disease-rate ranged from 24.3 to 100.6 DALYs each hundred thousand inhabitants between 2007 and 2008. The America presented an estimated 73,000 DALYs, with 131 DALYs each million inhabitant in 2004, the highest-number each million inhabitants [23].

2.7 Diagnostic-tool in Dengue Fever

Dengue could be diagnosed clinically. But, laboratory-test(s) are required to confirm the diagnosis. Definitive-diagnosis is important in epidemiological-surveillance and monitoring-reasons. Development of assays is happening and newer assays using much advanced technologies have been developed, though not fully validated [17,18].

The ideal dengue diagnostic-test would be one that is simple, rapid, and affordable having high sensitivity and specificity – which is able to differentiate between primary and secondary infection and be able to serotype the virus. The time-frame for laboratory-diagnosis is from the onset to ten days post-disease [17,18].

Diagnostic-tools currently are mainly serological-based, nucleic acid-based or antigen-detection [17,18].

The best diagnostic is the isolation of the virus or detection by direct immunofluorescence (IF), or genome-amplification via PCR [17,18], or detection of viral-antigen like NS1 using either ELISA or rapid lateral-flow test [17,18].

Presently, virus-isolation, PCR and Direct IF are carried out only in reference- and research-laboratories [17,18].

The NS1-test is additionally user-friendly. Apart from ELISA, many a rapid-flow test has been developed and validated [17,18].

This is found useful in the first five-day period of symptom when viraemia still exists. Serology is also useful in demonstrating sero-conversion from negative to positive IgM-antibody, or a four-fold increase in IgG antibody-titre in paired serum-specimens. Patients who are IgM-positive and are PCR-negative are classified as probable recent dengue-infection, in the reason that IgM-antibodies to dengue remain elevated till 90 days after the illness, and could have been from an infection that happened between two and three months ago [17,18].

In addition, it is important to note that cross-reactivity with various flavi-viruses, including West Nile virus (WNV), St. Louis encephalitis virus (SLE), Japanese encephalitis virus (JEV), Zika virus and yellow fever virus (YFV), do happen. But, these infections are very rare in Malaysia and are not outside the sensitivity and specificity of the test. Yet, a look into the patient's Recent Travel History can be helpful. A paired-sample, testing all of the flaviviruses, best provides a diagnosis as is to which flavi-virus it is, especially in those who present late after the onset of illness (> 5 days) when virus and viral antigens become undetectable [17,18].

In addition, a Microfocus-reduction Neutralization-test (based on the peroxidase/anti-peroxidase or fluorescein technique) and a Micro-neutralization Test based on an ELISA-format have been developed [17,18].

The development of rapid-assay in recent years has allowed patient-specimens to be tested at the point-of-care and primary-care situation. Most manufacturers of these claim that the tests are able to differentiate between primary and secondary dengue-infections [17,18].

Table 2. Current diagnostic-tests in dengue [17,18]

	Procedure	Description
1.	Real-time RT PCR	a. A positive result is definite proof of current infection b. Usually confirms serotype c. Where viral-load is high, virus can be isolated d. Negative PCR result should be treated as indeterminate, to be confirmed by a second sample using another marker (or quantitatively via serological tests);
2.	Quantitative or Semi-quantitative Serological-tests	a. Detect IgM and IgG which are best useful when conducted in pairs. b. Many commercially-available such tests. c. Such pairs enable determination of primary and secondary status as well
3.	NS1 ELISA	a. A useful tool b. This test is 100% sensitive
4.	The Plaque Reduction Neutralization Test (or the Fluorescent Reduction Neutralization) (PRNT/FRNT)	a. Still the most sensitive serological-test b. But not indicative of the total antibody-levels because non-neutralizing antibodies are not detected. c. Indicates the level of protective antibodies d. labour-intensive, time-consuming, expensive and requires good standardization
5.	The Haem-agglutination Inhibition assay	a. has been the gold standard for many years b. requires a paired-sample – and, skill in interpreting the results. c. tedious, time-consuming and usually conducted by reference laboratories only

Source: Meer Ahmad AM et al. (2018)

Table 3. The seven strategies under the National Dengue Strategic Plan 2015 – 2020 [17,18]

	Strategy	Description
1.	Dengue Surveillance	1. Includes eNotification since it is a notifiable-disease under the Prevention and Control of Infectious Diseases Act, 1988 2. Laboratory Surveillance 3. Dengue Outbreak Management 4. New breeding-sites 5. Strengthening information system 6. Legislation – heavier penalties 7. Strengthening Community Participation and Inter-sectoral Collaboration 8. Changing insecticide fogging formulation 9. Mass abating 10. Reducing case-fatality
2.	National Cleanliness Policy (A) and Integrated Vector Management (IVM) (B)	A. 1. The National Cleanliness Policy – holistic and integrated approach through the Concept of Inter-agency Blue Ocean Strategy 2. Focus on Clean Environment – Malaysia to become among cleanest countries, free from Infectious Diseases B. 1. Space spraying, including using Temephos EC or Bti in the hotspot areas 2. Residual spraying as a complementary measure 3. An effective waste collection system 4.Reliable water-supply system to reduce the need for additional water-storage 5. Cleanliness activities (Gotong Royong) 6. Advice on personal protection 7. Inter-agency enforcement at Construction-sites
3.	Management of Dengue Cases	Skillful Clinical Management
4.	Social Mobilization and Communication for Dengue	1. Community-involvement as a COMBI-volunteer 2. Communication through Mass-media and Social-media
5.	Dengue Outbreak Response	1. Epidemic Preparedness Plan: Dengue Outbreaks Operation Room at District and National-level; Inter-agency District Dengue Outbreak Committee chaired by DO; Dengue Task-force Committee at State and National-level 2. Early Detection of Epidemic and Response 3. Risk Communication
6.	Dengue Research	1. Focus on enhancing effectiveness, cost-effectiveness, sustainability and scale of existing interventions 2. Various thought, concept and new method 3. Collaboration with National Public Health Laboratory (NPHL) and Institute for Medical Research beside various such agency

Source: Meer Ahmad AM et al (2018)

Many biosensors are being developed as rapid-test for dengue. These use piezoelectric, optical or electrochemical method [17,18].

Recently nanoparticle-beads, mass-spectrometry, and micro-sequencing have been utilized and appear promising [17,18].

2.8 Dengue Prevention & Control

The present National Dengue Strategic Plan (2015 – 2020) comprise of [17,18]:

1. To strengthen the preparedness and response capacity to detect cases and

outbreaks toward immediate action, and
2. The National Strategy is developed based on SWOT-analysis beside the document "Global Strategy for Dengue Prevention and Control 2012-2020“ by the WHO.

In Malaysia, the current new directions in dengue-control include [17,18]:

1. Having all registered dengue cases confirmed by laboratory tests,
2. Increasing source-reduction activity, and
3. Reducing fogging-activity from two cycles to one cycle

New Tools and Strategy in the Prevention and Control in Malaysia consist of:

A. New strategy in hotspot-areas such as in Table 3. For the effective control of the dengue-vector mosquito-population, there is a need to combine several strategies, such as chemical, biological and integrated control. The chemical-insecticide is the most commonly used, as it is effective against both the larval and the adult mosquitoes [17,18].

   The ultimate aim of insecticide-control management is in two-part i.e. the control of Aedes-immatures and the control of the adult mosquitoes. The control of the adult, especially in a dengue-epidemic situation, is aimed at the killing of the infective female-mosquito. But, the control of Aedes-immatures is targeted toward the overall reduction of the mosquito population-density and, indirectly reducing the human-vector pathogen-contact to prevent dengue-transmission [17,18].

   One of the two common chemical-controls is Larvicide-application to treat household drinking-water containers which has low-relative toxicity and is safe for humans. The remaining technique is space spraying (Ultra low volume, ULV or thermal fogging), which is generally employed in emergency outbreaks of dengue [17,18].

   There is found now innovative new-strategy developed specifically to outsmart the dengue-vector mosquito. This is described in Table 3A. In the prevention and control of dengue-outbreaks, the use of household insecticide-products (HIP), such as the insecticide aerosol-spray has been very much a part of active and sustainable community-participation. Such are handy and fast-action, recently protracted-acting and metered with nano-technology, effective in killing all the mosquitoes and always ready-to-use. The dengue-hotspot communities should pro-actively do thorough spraying in the morning and in the evening every day within these premise, to ensure that no infective female Aedes-mosquitoes hiding within. In the non-hotspot community, such thorough-spraying need to be done only one time a week to ensure there is no Aedes-mosquitoes breeding inside such a premise. Thus, this aerosol insecticide-spray should be integrated in the overall dengue-vectors control-program for maximum control-result. Outside-fogging could also be carried out [17,18].

B. Specific protection: Primary Prevention of diseases classically comprises of Health Promotion and Specific Protection [17,18]. Health Promotion has been extensively outlined above. Specific Protection should comprise of an appropriate Mass Vaccination Program of Endemic Areas, and/or appropriate use of effective mosquito-repellents such as DEET, lemon eucalyptus or picaridin, and the appropriate use of mosquito-nets by day-sleeping children, the elderly and the infirm. The final two could be made available, subsidized, at Health Clinic(s) throughout the country [17,18].

In late 2015 and early 2016, the first dengue vaccine, Dengvaxia (CYD-TDV) by Sanofi Pasteur, had been registered in many a country to be used in individuals 9-45 years of age living in endemic areas. But overall, the much waited-for dengue-vaccine has been a disappointment both in its efficacy and its safety [17,18].

If a sufficiently effective and safe vaccine can be found, that could transform dengue fever into a vaccine-preventable disease, and the disease could be quickly brought to near-eradication level just like all the various previous vaccine-preventable diseases. Takeda Pharmaceutical Company Limited, (“Takeda”) in November 2017 announced the data from an 18-month interim analysis of the Phase 2 DEN-204 trial of its live, attenuated tetravalent dengue vaccine-candidate, TAK-003 (also referred to as TDV). This interim-analysis showed that children and adolescents who received TAK-003 had a relative-risk of symptomatic-dengue of 0.29 (95%

CI: 0.13–0.72) compared to children and adolescents in the placebo control-group [17,18]. TAK-003 was found to be safe and well-tolerated in terms of solicited local-reaction and systemic adverse-event, relative to the placebo control-group [17,18].

Fig. 3. Strategy 1: Dengue Surveillance

Fig. 4. Strategy 2: Appropriate case management

Fig. 5. Strategy 3: Community Education and COMBI

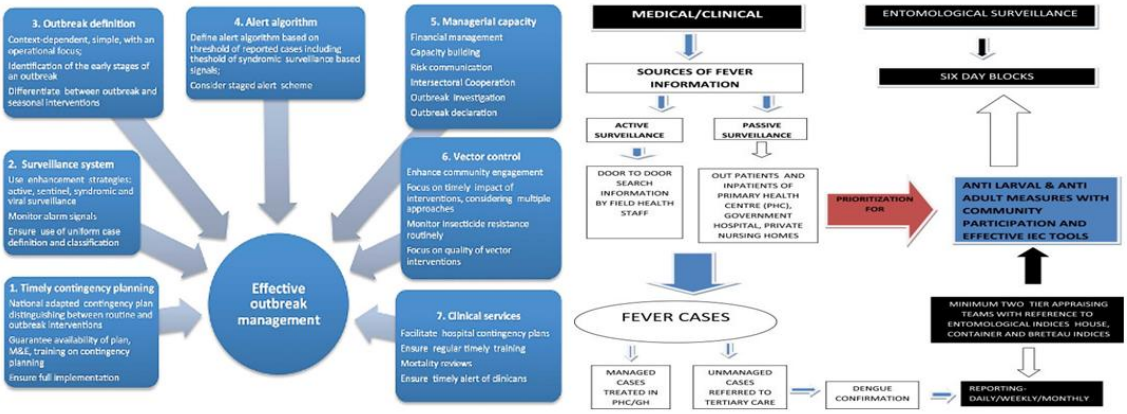

Fig. 6. Strategy 3A: Dengue Outbreak Response

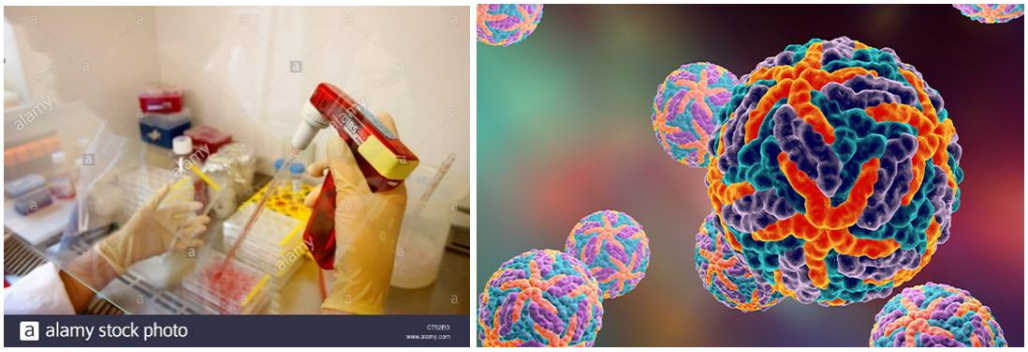

Fig. 7. Strategy 5: Dengue research

Table 3A. New strategies in hotspot areas (including concepts) [17,18]

	Strategy	Description/constraints
1.	Residual spraying	Read within Text outside this Table
2.	Larviciding activity using Temephos EC or Bti	Read within Text outside this Table
3.	Use of newer-generation insecticide	Read within Text outside this Table
4.	Use of novel ovi-trap and various innovative-method	Read within Text outside this Table
5.	Release of genetically-modified Aedes (A) or Wolbacchia-infected Aedes (B)	A. 1. Hampered by logistical-difficulty due to flight-range of Aedes viz-a-viz release-radii in heavily built-up areas B. 1. The same difficulty does not exist in Wolbachia-method in the reason that Wolbacchia-infection passed onto progenies – should be self-propagating, but in practice such propagation not found more than 100 meters per year 2. The strain of Wolbacchia shown to be effective in this method not able to survive ambient temperatures in the tropics. The claim is controversial. 3. The Method is undergoing pilot-study by IMR in Selangor
6.	Larviciding of primary water-sources such as the water treatment plant (A), together with Aerial-spraying (B)	A. 1.Similar to fluoridation of water 2.Pyripoxifen (after EIA done) or Bti 3. Was done in some part of Brazil B. 1. Aerial-spraying using US CDC Protocol C. The combined method can be implemented if a safe and cost-effective vaccine still not found, after pilot-study
7.	Isolation of Case	1. Not useful since 70-80% of infections are asymptomatic, yet infective 2. Besides that, diagnosis is usually made on 3rd to 5th day

Source: Meer Ahmad AM et al (2018)

TAK-003 is presently under evaluation in the Tetravalent Immunization against Dengue Efficacy Study (TIDES), a large-scale Phase 3 efficacy-trial presently conducted in eight dengue-endemic country Data from TIDES could be available in late 2018/19 [17,18].

The US National Institute of Allergy and Infectious Diseases (NIAID) has developed the LATV dengue-vaccine TV003/TV005. A single-dose of either TV003 or TV005 induced seroconversion to four DENV serotypes in 74-92% (TV003) and 90% (TV005) of the flavivirus-

seronegative adult and elicited near-sterilizing immunity to a second dose of vaccine administered 6-12 months subsequently [17,18].

The Phase III clinical trial of the TV003 commenced in February 2016 among the 17,000-volunteer in multiple location in Brazil to find out the efficacy and safety. The estimated primary completion date is June 2018, and the estimated study-completion date is December 2022 [17,18].

When vaccines are available which afford greater than 90% protection against all four serotypes, the risk of antibody-directed enhancement (ADE) in subsequent natural-infections, causing severe dengue, become remote in the reason that secondary-infections are rendered rare.

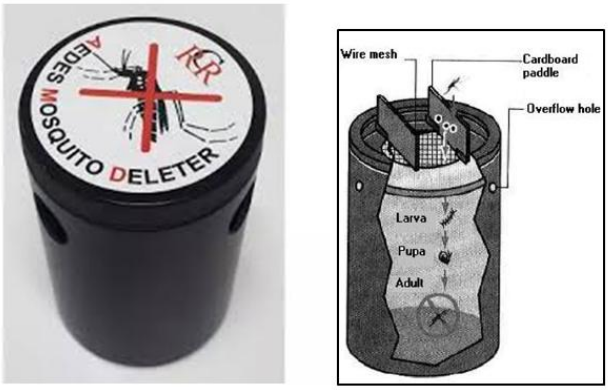

Fig. 8. Ovitrap

Fig. 9. New Innovative House-hold Spray

Fig. 10. Aerial mosquito spraying; dengue vaccine

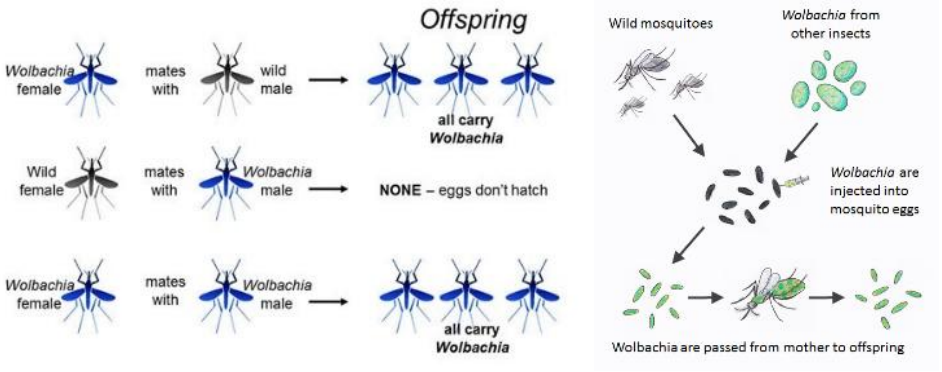

Fig. 11. Wolbachia-infected Aedes technique

Table 3B. Innovative New-strategy in Dengue-vector Control [17,18]

	Method	Description
1.	Attractant Toxic Sugar Baiting	a. Attract all the hungry and dehydrated adult-mosquitoes (male & female) when they emerge from pupae (especially first two days) b. Since nectar-meal is found scarce indoor, the bait is the most readily-available and attractive option. c. Only needs placement in strategic-location indoor d. Safe in the reason that not any chemical extruding into air or environment e. Mostly used as a supplement in control
2.	Attractive Lethal Ovi-position Traps	a. Found to make full use of the Aedes-vector mosquito's skip-ovi-position characteristic i.e. in using the female in a mechanical-carriage to cross-contaminate the remaining breeding-site which are beyond human-detection. b. Attracts gravid-mosquito to come and lay egg in the special-station that contain water and a lacing-formulation of oviposition-attractant. All (100%) of these egg cannot develop to adult mosquito. c. The combination (formulation) has the insect growth-regulator, IGR, which contaminates these female-mosquito - when they lay egg in the hidden breeding-site in the wild, such go on to cross-contaminate all the breeding-site and all the hidden-egg. d. All of the chemical used in this, all of a time stay inside the station - thus protecting all the natural-enemy of the mosquito and ensuring sustainable natural biological-control

Source: Meer Ahmad AM et al (2018)

Little new directions in research in dengue control and prevention have come about from the time 2015. Much is about climate-variable based, temporal/spatial (clustering) based dengue prediction modeling and early warning systems (of outbreaks) to help guide vector-control operation including the probability of dengue transmission and propagation in a non-endemic temperate area.

Olliaro P, et al (2018) beside writing in a same manner on critical-characteristic that an alert system should have to document trend reliably and trigger timely response (i.e., early enough to prevent the epidemic spread of the virus) to dengue outbreaks addressing a range of variable(s) that either indicate risk of forthcoming dengue transmission or predict dengue outbreaks that could be successfully applied to Early Warning and Response System (EWARS), had also written that summary of published literature show that controlling Aedes vectors require complex-intervention and point to the need in standardized energetic-effort with

disease-reduction as the measured primary outcome. Sampling vector populations, both here in a surveillance-aim and evaluation of control-activity, many a such researcher claim is usually seen carried out in an unsystematic way, limiting the potential(s) of entomological-surveillance toward outbreak prediction [24].

Olliaro et al additionally state that combining outbreak-alert and improved-approach in vector-management would help to overcome the present uncertainties about major risk-group or areas where outbreak-response should be initiated and where resource in vector-management need be maximized during the inter-epidemic period, concluding that evidence-collected could help policy-decision(s) [24].

Veras-Estévez BA and Chapman JC (2017) observed that health-work in the community educates and empowers citizens about recommended prevention-practices, and thus are valuable in implementing national dengue-initiative(s) on the ground. But, such health-message may not resonate with every community-member, resulting in low-adherence to recommended prevention-practices. Understanding the factor(s) associated with low-adherence to dengue prevention and control measure is found essential toward strengthening national dengue-initiative(s). The author additionally stated that health-work described the following perceived limitation in dengue prevention and control [25],

a) Limited individual economic resource(s);
b) Individual lack of awareness, education or action;
c) Limited cohesion among community member(s); and
d) Limitation in the sustainability of government intervention.

Rather I et al (2017) observe that the globally endemic-dengue cause a public health and economic limitation that has been attempted to suppress through the application of various prevention and control technique. The author(s) recommend broad-spectrum technique that are efficient, cost-effective, and environmentally sustainable [26].

Rafdzah Z et al (2019) in a questionnaire-study aimed to explore the perception and attitude of the Malaysian public toward early warning system and observe that such a system in dengue is meant to predict outbreaks and prevent dengue cases by aiding timely decision making and deployment of intervention(s) – but, only a system which is accepted and utilized by the public would be sustainable in the long run. The study revealed that although here the respondent(s) had been found very much aware of the connection between climate and dengue, about 45% did not know or were not sure how an early warning system could be used to predict dengue. The respondent(s) wanted to know more about how climate data can be used to predict a dengue outbreak. The author(s) felt that informing additionally on how climate could influence dengue-cases would increase public-acceptability and improve response toward a climate-based warning-system. Most such respondent(s) preferred television as the mean of communicating early-warning. A dengue warning-system is found necessary, but added community education is required [27].

3. DISCUSSION

The eradication of smallpox from the world in 1977 proved the feasibility of infectious-disease eradication, although the eradication of smallpox was not a planned-programme, but happened by chance - out of a well-executed vaccination-programme using a very effective and safe vaccine arising from the fact that the smallpox-virus is a monovalent and simple virus. In 1993, the International Task Force for Disease Eradication (ITFDE), began assessing the potential for global-eradication of many a infectious disease [28,29].

The ITFDE became initiated at the Carter Center of Emory University in 1988 by a grant. The ITFDE's scope had been to find out systematically the potential-eradicability of candidate-diseases, identify specific-barriers to the eradication that could be overcome through additional research or such-effort, and encourage eradication-effort when appropriate [28,29].

In the first two meetings in 1989, the ITFDE reviewed and modified the draft-version of criteria used to evaluate the potential-eradicability of eight diseases in the process of eradication or had been promoted to be eradicated by international-agencies, national-authority, and such. Criteria included thought toward the epidemiologic-vulnerability (e.g., lack of animal-reservoir and limited-duration of infectiousness) of the disease; availability of effective practical intervention; the impact of the disease on people's well-being; the presence of

national and/or global commitment to tackle the problem; and cost. In these meetings, two diseases (dracunculiasis and poliomyelitis, both of which had also been previously selected through Resolutions passed at the WHA) that had been judged to be eradicable, and three (leprosy, Chaga's disease, and onchocerciasis – recently added by trachoma and filariasis) to be candidate in elimination of transmission or elimination of clinical symptoms – and, three additionally had not been considered candidate(s) at that time. Importantly, the ITFDE also noted that critical-research need, if realized, might permit additional diseases to be eradicated eventually. In 2002, the ITFDE concluded measles could also be eradicated, and additionally put a mark on mumps and yaws [28,29].

Table 3C. The comparison of elimination-characteristic between malaria and dengue fever

Chain of transmission & causation of disease	Malaria	Dengue fever
Reservoir	a. sole vertebrate reservoir b. humans, essential component of transmission	a. sole vertebrate reservoir b. humans, essential component of transmission
Portal of Exit	a. mosquito-net b. mosquito-repellent c. protective-clothing d. isolation of cases	a. mosquito-net b. mosquito-repellent c. protective-clothing
Mode of Transmission	a. effective intervention b. perennial transmission c. health-infrastructure & money d. policy & legislation e. surveillance f. outbreak response g. information system h. community education/participation/ mass-media i. collaboration	a. effective intervention b. perennial transmission c. health-infrastructure & money d. policy & legislation e. surveillance f. outbreak response g. information system h. community education/participation/ COMBI/ mass media i. collaboration
Portal of Entry	a. prophylaxis b. vaccine-development c. mosquito-net d. mosquito-repellent e. protective-clothing f. isolation of cases	a. vaccine-development b. mosquito-net c. mosquito-repellent d. protective-clothing
Susceptible host	a. sufficiently simple and practical diagnostic-tools toward early detection b. humans, essential component of transmission c. fever d. notification	a. sufficiently simple and practical diagnostic-tools toward early detection b. humans, essential component of transmission c. fever d. notification
Agent	a. humans, essential component of transmission b. life-cycle/transmission understood c. diagnostic tools/research d. well-documented characteristics e. anti-malaria drugs/reducing mortality	a. humans, essential component of transmission b. life-cycle/transmission understood c. diagnostic tools/research d. well-documented characteristics e. effective clinical-management/reducing mortality

Chain of transmission & causation of disease	Malaria	Dengue fever
Environment	a. not amplify in environment b. environmental modification technique(s) c. human habitat and agriculture d. insecticide/larvicides e. vector-control/innovative methods f. spatial, temporal and climate aspect g. waste-collection/cleanliness policy h. reliable unsupportive water-supply	a. not amplify in environment b. environmental modification technique(s) c. human habitat and agriculture d. insecticide/larvicides e. vector-control/innovative methods f. spatial, temporal and climate aspect g. waste-collection/cleanliness policy h. reliable unsupportive water-supply

The US Centers for Disease Control had remarked then that these were the factors/conditions that enabled the eradication of smallpox:

a) No reservoir of the virus existed except humans;
b) Nearly all persons infected with smallpox had an obvious, characteristic rash and were infectious not more than during a relatively brief-period;
c) The natural-infection brought on permanent immunity; and
d) A safe, effective (even in newborns), and inexpensive vaccine had become available that is also very stable in the tropical-environment [28,29].

In addition, the CDC had noted that the different WHO-region(s) had also established regional-goal(s) to eliminate polio, measles, or neonatal tetanus over the coming decade, beginning with the elimination of polio from the America by 1993. India and China had aimed to eliminate leprosy by 2000, and the United States had set a national goal of eliminating tuberculosis by 2010. Achieving some or all of these early-milestone had been expected to gather increased-support toward global-eradication of selected-diseases [28,29].

The Center also noted that the public-health strategy of disease-eradication/elimination offered much advantage over disease-control when eradication/elimination is adopted against appropriate, well-chosen targets. The benefit of eradication is permanent and only need a finite cost, in very much the same manner beside, elimination – whereas, the cost of control-effort of the same disease needed to be maintained indefinitely. As an example, the United States invested $32 million in syphilis-eradication programme, SEP, over a 10-year period; this amount is equivalent to former U.S. cost and expenditure every 3 months in routine-vaccination and management of complications. The United States government had been investing in excess of $50 million annually to maintain the polio-free status and an estimated $25-$50 million to keep domestic-measles at a low-level - these figures not reflecting the cost of vaccination in the private-sector [28,29].

The CDC said that time-limited goal of eradication/mobilization allows mobilization of support at added-readiness compared with a control-programme. An important corollary-requirement in global-eradication is that the unaffected-country frequently need to provide material-assistance where needed [28,29].

The current ITFDE (II) is constituted with support initiated by the Bill & Melinda Gates Foundation to The Carter Center in November 2000 [28,29].

The ITFDE identified scientific-feasibility and political-support as the two primary-factor on whether a disease could be eradicated/eliminated [28,29].

Condition identified that make it scientifically feasible to eradicate a disease include [28,29]:

a. Epidemiologic-vulnerability. A disease could be considered vulnerable if it:

- Does not spread easily;
- There is a natural cyclical-decline in prevalence;
- There is a naturally-induced immunity;
- It is easily diagnosed; and
- The duration of any relapse-potential is brief.

b. Availability of an effective and practical intervention. Such interventions could:

- Include a vaccine or various remaining primary-preventive measure,
- A curative-treatment, or
- A mean of eliminating vectors.

Ideally, intervention should be effective, safe, inexpensive, long-lasting, and easily deployed.

c. Demonstrated feasibility of elimination. A disease that has been documented to have been eliminated from an island or some geographic-unit can be accept a candidate for eradication.

The ITFDE's stand is, even if it is scientifically feasible to eradicate a disease, there are also additional non-scientific condition that must be taken to thought, such as [28,29]:

- The perceived burden of the disease
- The expected cost of eradication/elimination
- The synergy of eradication/elimination effort with different intervention(s)
- A necessity in eradication/elimination rather than control.

Malaria has been included as targeted toward elimination, and the previous MEP-country particularly, including Malaysia, have adopted elimination over control. But, although here that the ITFDE has held 33 meetings from the time 1993, dengue fever has remained left out of eradication/elimination. This author(s) has shown above why dengue fever is very much found to meet with the criteria in every way – especially elimination.

In May 2002 during its 55th session, the World Health Assembly (WHA, the WHO's governing body) sought the development and implementation of a global strategy for the prevention and control of dengue and dengue haemorrhagic fever [30]:

'The Fifty-fifth World Health Assembly,

Recalling resolution WHA46.31 and resolutions CD31.R26, CD33.R19 and CD43.R4 of the Directing Council of the Pan American Health Organization on dengue prevention and control;

Concerned that an estimated 50 million dengue infections occur annually and that the geographical-spread, incidence, and severity of dengue fever and dengue haemorrhagic fever are increasing in the tropics; Recognizing the growing burden of disease, particularly among children, and the social and economic impact of dengue epidemics;

Acknowledging the progress made in reducing the case-fatality rates of dengue haemorrhagic fever in some countries;

Appreciating that significant advances have been made in the development of dengue vaccines, although they are not yet available for public health use;

Recognizing that prevention or reduction of dengue viral transmission entirely depends on control of the mosquito vector Aedes aegypti and, to a lesser extent, A. albopictus;

Aware that dengue vector-control programmes have had considerable success in the past, but that sustained suppression of vector populations today largely depends on the commitment of governments and community participation in both planning and intervention strategies and implementation of control measures to prevent the breeding of A. aegypti;

Further acknowledging that, at the International Conference on Dengue and Dengue Haemorrhagic Fever (Chiang Mai, Thailand, 20-24 November 2000), more than 700 public health specialists from 41 countries recommended that all countries at risk of dengue viral transmission should develop and implement sustainable prevention and control programmes,

1. URGES Member States:

(a) To advocate increased commitment and allocation of additional human and various resources for improved and sustained prevention and control efforts and strengthened research;
(b) To build and strengthen the capacity of health systems for management, surveillance, prevention, control and management of dengue fever and dengue haemorrhagic fever;
(c) To strengthen the capacity of diagnostic laboratories, taking into account the fundamental importance of laboratory diagnosis to confirm etiology and to strengthen clinical and epidemiological surveillance for dengue fever and dengue haemorrhagic fever;
(d) To promote active intersectoral partnerships involving international,

regional, national, and local agencies, nongovernmental organizations, foundations, the private sector, community and civic organizations;

(e) To pursue, encourage and support the development, application, evaluation, and research of new and improved tools and strategies for prevention and control of dengue fever and dengue haemorrhagic fever;

(f) To strengthen health measures at borders for vector control and opportunities for diagnosis and treatment to optimize regional resources;

2. URGES various specialized agencies, bodies, and programmes of the United Nations system, bilateral development agencies, non-governmental organizations, and the various concerned-group to increase the cooperation in dengue fever prevention and control, through both continued support toward general health and social development and specific support to national and international prevention and control programmes, including emergency control;

3. REQUESTS the Director-General of WHO:

(a) To develop further and support the implementation of the global strategy for prevention and control of dengue fever and dengue haemorrhagic fever through integrated environmental-management;

(b) To continue to seek resources for advocacy and research on improved and new tools and methods for dengue fever prevention and control and the application;

(c) To study the need for and feasibility of incorporating the surveillance and research of different arthropod-borne viral infections, such as Japanese encephalitis, West Nile, and such emerging-diseases, in the surveillance-system for dengue fever;

(d) To mobilize financial-resource to be spent on vector-control and research on vaccines.'

The author(s) here are certain that it is now time to start on the elimination of dengue fever and dengue hemorrhagic fever, preferably nationally and regionally, aimed at grouping (coalescing) subsequently to become a global programme. The availability of a safe and effective vaccine, when such a vaccine is found to arrive, can only be seen as an added impetus here in case found affordable and cost-beneficial. But, the diligent application of many a already available method outside of vaccine can also bring about the elimination of dengue fever and DHF – and such method(s) can be seen very cheap but cost-effective, beside found safe on the environment.

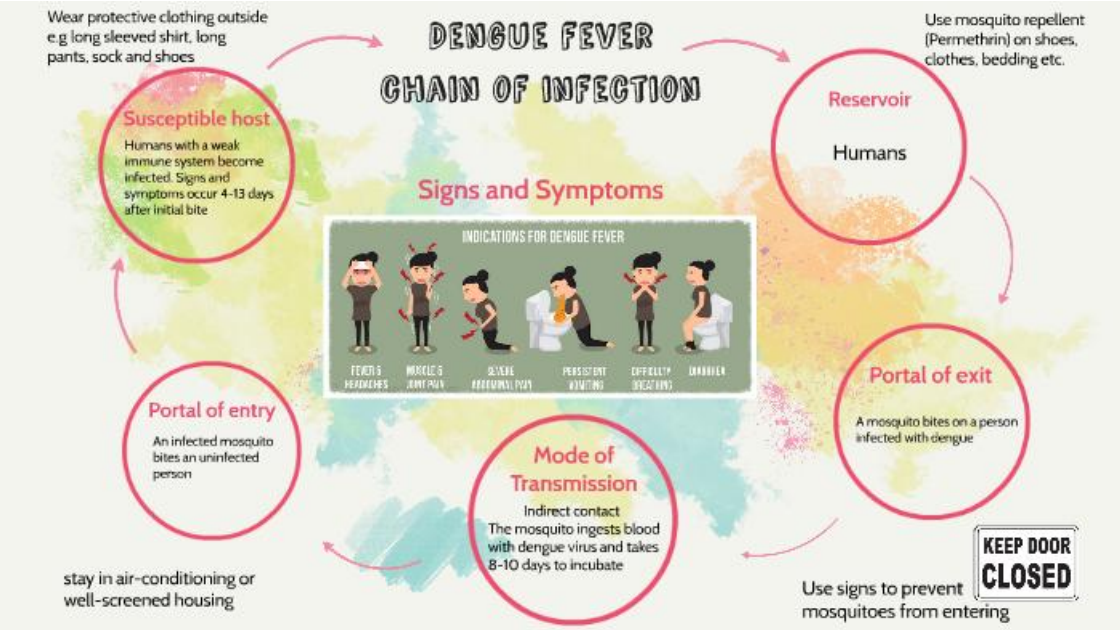

Fig. 12. Chain of Transmission in dengue fever
Source: Prezi Inc.

In a concern of infectious-diseases, primary-prevention including control/elimination aim at the weakest point of the Chain of Transmission (See Fig. 12).

4. CONCLUSION

Dengue fever epidemics are expensive and affect a high percentage of the population. The Response should include establishing enhanced-surveillance toward acute febrile-illness or conducting surveys to determine:

- The extent of the epidemic;
- Ensuring availability of dengue diagnostic testing;
- Ensuring appropriate medical-care toward cases and surge-capacity in medical-facility to handle the increase in cases;
- Coordinating community-message and community-education, in a repeated enough manner, to ensure people with symptoms seek medical attention and to ensure all aspect of people's need to act to eliminate dengue fever are well-understood;
- Conducting vector-surveys and source-reduction activity;
- Providing education in use of propellant-insecticide, mosquito-repellent and mosquito-net beside the subsidized selling of these at primary care facility and where appropriate, applying IRS in home(s) and building(s) [12].

Available mosquito-repellent such as DEET, picaridin and lemon-eucalyptus would first need to have validation-study done to confirm efficacy and safety, beside to derive the dose-required and the frequency-of-use. Pilot-study in larviciding primary water-supplies carried out together with aerial-spraying, can be found cost-beneficial.

The dengue-scourge could get worse if not acted upon quickly and could spread to involve additional countries. Mankind can eliminate dengue fever, even if not eradicate the disease, in a very much feasible and cost-beneficial programme, beginning in nation and region of the world, prior to grouping (coalescing) to become a global-programme.

DISCLAIMER

The research was not funded by the producing company rather it was funded by the personal effort of the author.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Dr. CA Koay declares that he is Technical Manager of a Firm that sells one brand of the 'mini-aerosol spray-insecticide', one brand of the 'attractant baiting' and one brand of the 'ovi-position traps'. Dr. Meer Ahmad A. M. declares that he does not have any Conflict of Interest whatsoever, in writing this Article.

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