DISEASE VECTORS – THE NEED FOR VIGILANCE

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INTRODUCTION

As the last half of the final decade of the 20th Century runs its course, it is recognized (Knudsen and Slooff, 1992) that urban health authorities in many countries around the globe are alarmed by the rise in vector-borne diseases, due to increased densities of disease vectors which present ever greater burdens for their control in vector and pest control programmes. As Mott, *et al.*, (1990) noted, the distribution and epidemiology of parasitic diseases in both urban and peri-urban areas of endemic countries have been changing as development progresses. The real or potential threat for the introduction or reintroduction of new and exotic vector species and the potential transmission of emerging or reemerging vector-borne diseases into countries and territories from neighbouring areas is a major concern.

There are numerous factors contributing to increases in vector-borne diseases, but among the most salient are densely crowded urban centres, inadequate sanitary conditions and the speed and frequency of air and surface transport which provides rapid movement of people, tropical diseases, insect pests and vectors around the globe and reasons related to an increase in the interaction of such. These are combined with the appearance of new or reintroduced vector species, selective resistance by vectors and disease organisms, increased virulence of viruses and bacteria, altered patterns of human behaviour, mechanisms of genetic variability and reduced effective vector control due in part to a lack of real commitment and political will.

Krause (1994) stated the case clearly when he indicated that "Microbes and vectors swim in the evolutionary stream and they swim much faster than do we. Bacteria reproduce every 30 min; for them a millennium is compressed into a fortnight. Microbes were here, learning every trick for survival, 2 billion years before humans arrived and it is likely that they will be here 2 billion years after we depart. Furthermore, science cannot halt the future occurrence of new microbes, which emerge from the evolutionary stream as a consequence of genetic events and selective pressures that favour the new over the old. It is nature's way. For all of these reasons, old and new infections will occur in the future as they have in the past. Surveillance efforts, both in the United States and other regions of the world, will be needed to blunt the emergence of such infections and to forestall epidemics and pandemics."

Indeed greater vigilance and increased surveillance is required by disease control experts at local, national and international levels to facilitate and advance all efforts towards the prevention and control of vector-borne and other infectious diseases.

BURDEN OF VECTOR-BORNE DISEASES

It is estimated that over 500 million persons, one in every ten, suffer from one or more vector-borne tropical disease. Both urban and rural populations living in tropical and sub-tropical areas are at high risk for vector-borne disease transmission. Risk for many vector-borne diseases is difficult to assess, but for malaria alone it exceeds 40% of the world's inhabitants and for dengue, the most important mosquito-borne arbovirus infection, it is 2/5ths of the human population.

The burden of illness, incapacitation, disfigurement and death attributed to tropical diseases impose serious constraints to social and economic development. Economic losses to the 190 Member States of the World Health Organization runs into several thousands of millions of US dollars each year. One of the objectives and priorities of the World Health Organization (WHO, 1994) as determined by the international health community is: "To eradicate, eliminate or control major diseases constituting global health problems".

Proceedings of the Second International Conference on Urban Pests.
K.B. Wildey (editor). 1996

The following review of the epidemiological status and significance of several vector-borne diseases, ranging from malaria to African trypanosomiasis, is extracted from WHO (1995a).

Bruce-Chwat, (1987) noted, that the "problems of malaria and of its control are a paradigm of the scale and complexity of the dilemma of life and health in the Third World".

Malaria, a mosquito-borne disease, affects some 90 countries with a population at risk approximating 2 300 million persons. Some 1.5 to 2.7 million deaths occur per year of which one million occur among children under the age of five years. During this century alone there have been an estimated 25 million deaths, the greatest majority befalling Africa. There are an estimated 300–500 million clinical cases per year, of which 90% are found in Africa. In terms of disability adjusted life years (DALYs), Malaria is estimated at 35.73 million DALYs.

Dengue and dengue haemorrhagic fever (DHF), transmitted by peri-domestic *Aedes* mosquitos, are the most important and rapidly rising arbovirus infections in the world, (WHO, 1996) ranking high among the new and newly emerging infectious diseases. In affected countries, the debilitating symptoms of dengue and death from DHF and dengue shock syndrome (DSS) are inflicted upon the entire social strata, but frequently affect the young. Most cases are reported from densely populated metropolitan areas in South-east Asia, the Americas, Western Pacific, Africa and parts of the Eastern Mediterranean area. There are at least 100 countries which have been or are endemic since 1975.

The population at risk ranges from 2 to 2.5 billion person residing in crowded urban areas, with an ever growing number of cases from rural areas in South-east Asia, resulting from the semi urbanization of some rural areas. There are up to 3 million cases per year, of which an estimated 500 000 are hospitalized, 95% are children under the age of 15 years. Morbidity exceeds 20 000 per year. In many countries, dengue and DHF/DSS outbreaks are the leading cause of hospitalization of young children. The number of dengue and DHF outbreaks and epidemics has increased significantly during the past decade. During the period from the early 1950s until 1970, nine countries reported outbreaks of DHF. From 1970 until 1995, there were an additional 32 countries, nearly a four-fold increase affected by severe outbreaks of DHF. To date there have been 41 countries who have had to address problems of DHF.

Chagas disease, transmitted by triatomid or assassin bugs, is endemic in 21 American countries from Mexico to Argentina with a population at risk estimated to be 100 million persons, more than half of whom reside in six countries: Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay. Approximately 18 million person are infected with *Trypanosoma cruzi*. In 25% of those infected, the disease evolves into an irreversible cardiac form, in 6% into a digestive form and in 3% into a neurological form. Mortality is 45 000 deaths annually, 10% of which is in the most productive 15–35 year age group. DALY's are estimated to be 2.74 million.

There are 76 countries affected by the mosquito-borne lymphatic filariasis and a population at risk due to both *Wuchereria bancrofti* and *Brugia malayi* approaches 1.1 billion, with an estimated 100 million infected. The number of disabled individuals approaches 43 million, in terms of lymphoedema/elephantiasis or hydrocele. DALY's are estimated at 0.85 million.

Onchocerciasis (WHO, 1995b), transmitted through the bite of the *Simulium* blackfly, is endemic in 34 countries on the African continent. The population at risk approximates 123 million of whom nearly 18 million are infected. The number of onchocercal blind or severely impaired is estimated at 535 000 individuals.

Leishmaniasis, carried by Phletotomine sandflies, covers a wide range of diseases with different epidemiological and clinical manifestations, including the most prevalent form, cutaneous and the visceral form of leishmaniasis or kala azar, the latter being nearly always fatal if untreated. Kala azar causes large-scale epidemics. The number of countries considered to be endemic is 88, with a population at risk estimated to be 350 million. The number of individuals infected is thought to be 12 million persons. Ninety percent of visceral leishmaniasis is reported from Bangladesh, India, Nepal and the Sudan, while 90% of cutaneous leishmaniasis is found in Afghanistan, Brazil, Iran, Peru, Saudi Arabia and Syria. The annual incidence is from one to 1.5 million cases of cutaneous and 500 thousand visceral. The burden of disease is estimated at 2.06 million DALY's.

African trypanosomiasis, transmitted through the bite of the tsetse fly, is found endemic in 36 countries, mainly located in sub-Saharan Africa. The population at risk is estimated to be 55 million people, with 25 000 new cases reported each year. That figure does not accurately reflect the true epidemiological situation, as it is estimated that over 300 000 people are most likely to be infected, mostly from rural areas. The disease is an important cause of morbidity and mortality in at least ten countries. The burden of disease is estimated at 1.78 million DALY's.

DISEASE VECTOR SURVEILLANCE

There are useful tools today which can aid health planners and epidemiologists in attempting to monitor the presence and/or absence of vectors of tropical diseases and to anticipate disease outbreaks, allowing time to enact control measures. Among those being more frequently used is that of mathematical modelling (Krause, 1994) and the second is the use of a Geographical Information System (GIS). Both are of significant relevance in vigilance monitoring. When either is built upon solid field data, taking into consideration pertinent variables, accompanied by reliable interpretation, accurate forecasting along with the preparation of distribution maps can be valuable for management use.

These and similar tools can enable disease control specialists to predict, within some degree of reliability, potential and perhaps future courses of vector-borne and other types of disease outbreaks. Next in importance to an accurate surveillance and vigilance system is the rapid reporting of findings regarding the presence of new disease vectors and disease outbreaks. Such is essential in order to alert disease control managers and those responsible for informing the international community.

Malaria surveillance in endemic and non-endemic countries remains high on the agenda. Kitron, *et al.* (1994) reported on a computerized surveillance system in Israel, of monitoring anopheline vector mosquito breeding sites as well as imported malaria cases using GIS. Such monitoring consisted of accessing risk of malaria transmission through evaluating entomological data considering vectorial capacity, flight range and mapping of known vector breeding sites and epidemiological information concerning imported human cases.

Castelli, *et al.* (1994) remarked that the number of people travelling from the tropics to malaria-free areas has increased tremendously, being paralleled by the number of imported malaria cases, along with imported mosquitos transmitting the infection to persons living or working adjacent to international airports. In addition malaria mosquitos were being released from the baggage of international travellers, far from the landing area also posing a risk of disease transmission. This underlines the need for continued vigilance for monitoring the introduction of malaria vectors from the tropics.

Layton, *et al.* (1995) reported on two cases of *Plasmodium falciparum* malaria in people in New York City who had no recent travel histories or blood-borne exposure. An epidemiological investigation confirmed the absence of risk factors for the acquisition of malaria. The individuals lived in separate houses in the same neighbourhood of Queens, New York and had onset of illness within a day of each other. Malaria was probably transmitted by local anopheline mosquitos which had fed on infected human hosts. The occurrence of mosquito-transmitted malaria in New York City demonstrates the potential for the reintroduction of malaria into areas that are no longer endemic, emphasizing the need for continued surveillance and prompt investigation.

Easton (1994) made the observation that due to recent urbanization of Macau, which geographically consists of two small islands and a peninsula of land connected to a larger island area of mainland China, that there has occurred a decline to zero in populations of several anopheline vectors of malaria. However, optimal habitat has increased for culicine mosquitos including among the most abundant, *Culex quinquefasciatus*, *Cx. sitiens* and *Ae. albopictus*. Such nuisance species and potential disease vectors present the threat of transmission of other vector-borne diseases.

The need for vigilance is exemplified in many ways. In the course of the International Drinking Water Supply and Sanitation Decade, 1981–1990 over 1500 million people were given access to an adequate and safe water supply, however, because of rapid population growth, and other reasons, approximately 1025 million people in developing countries remained without a satisfactory water supply (WHO, 1992; UNDP, 1992). With respect to the provision of improved water supply in both urban and rural areas of the globe, there has been growing concern to determine whether increased water supply has an impact upon vector-borne disease vector densities and amplification of disease transmission.

Ilkal, *et al.* (1991) reported on an outbreak of dengue fever in villages in Maharashtra State, India and made the observation that in certain areas where piped-borne water was introduced, it often was inadequate, resulting in an increase in the practice of storing water. They reported that this favoured the creation of conditions suitable for the breeding of *Ae. aegypti.*

The authors indicated that no discrete data was available to ascribe the role of piped water supply in augmenting the dengue vector's breeding potential in India. However, they noted that in areas where piped water supply was provided in one section of a village by extension of pipes from the village well, that it was only in that part of the village that cement tanks existed for the storage of water, and there *Ae. aegypti* was found breeding. *Aedes aegypti* was not noted in the rest of the village. A dengue outbreak in June and July 1988 was preceded by high vector indices, linked to provision of water supply as a part of the process of village development.

Such reports lend credibility to observations that although in previous decades, dengue was principally recognized as a disease mainly of urban areas, that now there are reports of rural outbreaks of dengue and DHF in China, India, Thailand, Indonesia, Malaysia and other Asian countries.

Increases in dengue cases require improved surveillance to determine the presence of *Aedes* vectors in rural areas where improvements in water supply have resulted in increased water storage practices and the creation of expanded vector breeding habitat. In instances where there is an increase in mosquito densities accompanied by the introduction of dengue serotypes, through infected individuals or infective mosquitos, there the risk of disease transmission is real.

Outbreaks of plague have occurred periodically throughout man's history. In Tanzania, the disease has been endemic for more than a century, being most likely introduced long before the arrival of Europeans (Kilonso, Makundi and Mbise, 1992). With proactive surveillance over a ten year period (1980–1990), it was determined that plague was active in a focus despite control measures, and that common reservoirs and efficient vectors were present. Furthermore, dogs were probably involved in the epidemiology of plague and that the flea, *Pulex irritans* was not susceptible to the insecticide used. The authors recommended further surveillance and monitoring to understand the persistence of the focus.

Dias (1991) reported on Chagas disease control in Brazil which had targeted the control of domestic triatomine bugs to reduce disease transmission, since more than 80% of human disease is attributable to transmission by these vectors. The Brazilian Chagas Disease Programme attack phase began in 1983 after a political and technical decision to cover all the 2400 municipalities of the endemic area with regular insecticide spraying. Entomological results have been excellent with nearly 70% of the area showing a drastic reduction in disease transmission. The programme is now in the vigilance phase carried out at regional levels and supported by intensive community participation. The author indicated that the great challenge is to maintain a continuous and effective surveillance against triatomines in the poorest and more isolated rural areas of the country.

Lyme disease, which was virtually unknown 20 years ago, is now the most common arthropod-borne disease in the United States (Barbour and Fish, 1993). In some areas the emergence of this disease is in part a consequence of reforestation and the rise in deer populations. Unfortunately, an accurate estimation of the importance of Lyme disease to human and animal health has not been possible due to difficulties in the diagnosis and obtaining reliable surveillance data.

In the western extension area of the river blindness or Onchocerciasis Control Programme in West Africa (OCP), covering five countries of Guinea, Guinea-Bissau, Mali, Senegal and Sierra Leone, entomological surveillance has been carried out from 1986 to 1990 to collect entomological data on the vectors of onchocerciasis to monitor against resurgence of the disease vectors following the satisfactory control of disease transmission (Seketeli *et al.*, 1993).

Nelson (1994) observed that in most disease vector control programmes in the world that little value was placed on sampling methods for surveillance against the importation of vectors, determination of vector distribution, vector incrimination, monitoring of entomological risk factors and the evaluation of control measures. The author stressed the value of using appropriate attractant and non-attractant collecting methods for each situation and the value of using more than one collecting method in surveillance programmes.

There have been accounts of alien species introduced either intentionally or accidentally into new ecosystems during our life-time (Smith, Carter and Laird, 1984). In a number of instances where a surveillance system was insufficient to detect an imported species, the results have been significant.

The most recent and dramatic case is the introduction of the secondary vector of dengue, *Ae. albopictus*, into the Americas in the early 1980's and its continual spread across that continent, principally through the used tyre trade. Reiter and Darsie (1984) collected a single female near the centre of Memphis, Tennessee using a CDC Gravid Mosquito Trap. At the time their report was dismissed as being an isolated, dead-end introduction possibly coming from Japan via surface cargo of the Asian tiger mosquito.

On 30 January 1986, the first confirmed infestation of the species within the continental USA was reported by the Center for Disease Control (CDC) (Moore, 1986) as published by Sprenger and Wuithiranyagool (1986), indicating that the species was established in Harris County, Texas. By mid-1992 there were 75 out of the 254 counties in Texas with *Ae. albopictus* densities (Womack, 1993).

Knudsen, (1986) addressed the question of the significance concerning the introduction of the species into the south-east United States . Infestations followed in Louisiana, Florida and Georgia, the latter, in 1994 became the first state to document *Ae. albopictus* in all of the state's counties*. Florida likewise joined such ranks in late 1994 (O'Meara, 1994). As of November 1994, it was reported that *Ae. albopictus* was believed to be established in 537 counties in 24 states of the United States, including Hawaii, with Chicago, Illinois being the northern most infestation. If one includes the US territory of Guam, the total is 25 states or territories (Pers. communication – Carl Mitchell and Roger S. Nasci).

The species has spread further south into Mexico, and to the Dominican Republic in the Caribbean. It is unofficially reported to be present in Cuba. It first appeared in Brazil in 1986, and it has now spread to seven states, including 673 counties or municipalities. In Europe, the first published report was from Albania in 1987 by Adhami, followed in 1990 by Genoa, Italy (Sabatini *et al.* 1990 and Pozza and Majori, 1992). Further spread within Italy to include ten regions and 19 provinces has been report by Knudsen, Majori and Romi (1996).

In Nigeria *Ae. albopictus* was first collected in Delta and Benue states as a result of an investigation of an outbreak of yellow fever in 1991 as reported by Savage, *et al.* (1992). Additional infestations have been reported from four other states. In Africa, inasmuch as imported cargo is not routinely inspected for mosquitos, other undetected infestations of *Ae. albopictus* may exist elsewhere on the continent (MWR, 1992).

SUMMARY

This review of the growing significance of disease vectors and the need for increased vigilance has stressed the importance for the careful monitoring and documentation of the presence or absence of vectors of a number of vector-borne diseases. Of the vector-borne diseases which have been addressed, several are among the newly emerging or re-emerging diseases. All those discussed potentially impact upon approximately half of mankind living in tropical and semi-tropical areas of the globe as well as affecting tourists and transient visitors to such regions. The likelihood for the introduction of insect vectors and the spread of vector-borne diseases affecting man in new areas of the globe is real.

Disease and vector modelling and the use of GIS can be valuable tools for vector surveillance if the field data upon they are based and the accompanying interpretation are reliable. Resutant information can assist in predicting and monitoring vector populations and the course of disease outbreaks and to aid in their prevention and control. Regardless of the surveillance system employed vigilance is crucial.

Next in importance to an accurate surveillance system is the rapid reporting of findings regarding the presence of new disease vectors and disease outbreaks. Such is essential in order to alert disease control managers and those responsible for informing the international community.

*A Perspective on *Aedes albopictus* 1994, an unpublished document provided by Dr C. Mitchell, CDC, Fort Collins, CO, USA, p. 107.

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