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Vector-borne disease prevention: the need for a joint South Pacific approach

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There seems to be a growing potential for widespread outbreaks or the introduction of vector-borne diseases in the South Pacific region, particularly those that are mosquito-borne.[1,28,29,32] New Zealand for example, is at risk from the introduction and subsequent vector-borne disease outbreaks.[2,3]

Exotic mosquito vectors are established in the country (*Aedes notoscriptus*, *Aedes camptorhynchus*, and *Culex quinquefasciatus*) and other exotic species are regularly intercepted at New Zealand borders, including the Asian tiger mosquito *Aedes albopictus*.[3,4] In addition, an increasing number of people are travelling between New Zealand and countries where vector-borne diseases are endemic, which leads to a regular influx of viraemic travellers.[5,30,31] For instance, in the past few years there have been numerous outbreaks of dengue in the South Pacific whose impact reached New Zealand, where a significant increase in the number of cases of imported dengue was observed.[6,30]

In 2007, of the 114 notified imported dengue cases, the most common countries travelled to during the incubation period were the Cook Islands (65.8% of cases) and Samoa (9.6% of cases).[30] Such human pathogens could be passed, under favourable conditions, to local or future introduced vectors.

The potential hazards to New Zealand are no different from those in other Pacific countries,[32] with certain arboviruses being of particular significance and therefore concern, such as West Nile virus (WNV), Ross River virus (RRV), and more recently Chikungunya virus (CHIKV). An outbreak of CHIKV in the Réunion Island in 2005–6, in which *Ae. albopictus* was incriminated as the vector, led to an estimated 255,000 cases (affecting over 30% of the population), including 77 deaths.[7] More recently, approximately 200 cases of CHIKV infection occurred in northern Italy, in which *Ae. albopictus* was again the likely vector involved.[8] CHIKV has consequently been identified as an emerging pathogen,[7,9] which poses a risk to other temperate areas, including New Zealand and Australia, should a vector such as *Ae. albopictus* become established.[17]

For the Pacific Islands the risk of a CHIKV outbreak is greater as another vector (*Aedes polynesiensis*) is widespread in the region, and *Ae. albopictus* is also established in Cook Islands, Fiji, French Polynesia, Guam, New Caledonia, Papua New Guinea, Samoa, Seychelles, Solomon Islands, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna.[10] In addition, arboviruses can mutate rapidly to adapt to new locally available vectors, as also demonstrated recently by CHIKV.[11]The authors acknowledge that no locally-acquired cases of RRV have been reported in New Zealand 11 years after *Ae. camptorhynchus* was first recorded in the country. This may be a result of limited known distribution of the species, low human population densities, an ongoing surveillance programme, and a multi-million dollar investment

in an eradication campaign. These two programmes in particular, would not likely be possible in less wealthy countries in the South Pacific, which would consequently be at a greater risk of a disease outbreak following the arrival of a new vector or pathogen.

West Nile virus is another mosquito-borne pathogen that could potentially arrive in the South Pacific.[12] For New Zealand, it has been proposed that the distribution of WNV would be most likely determined by the distribution of suitable vectors,[13] which is potentially limited as the only known WNV vector in the country is *Cx. quinquefasciatus*.[14] However, recent mosquito collection and surveillance data indicate this species is distributed further afield than previously thought and it seems to have been spreading southwards.[15] Furthermore, since the majority of native mosquitoes in New Zealand are most likely ornithophilic (primarily bird-feeders) and some appear to occasionally feed on humans,[16] their potential role as WNV vectors certainly needs investigation.[12]

The establishment of *Ae. albopictus* would increase the likelihood of a WNV outbreak occurring as well,[17] since this species has been found to be a very efficient laboratory vector of WNV,[18] and it may be implicated in the ecology of the disease due to the isolation of the virus from this species in nature.[14] More recent studies have highlighted the potential role of *Ae. albopictus* as a bridge vector of WNV.[34] Furthermore, it is important to point out that although these ecological limitations exist in New Zealand, the same would not apply to other South Pacific areas, as potential WNV vectors are present in all Pacific Islands.[32]

Compounding the threat to the South Pacific region (especially to the more temperature areas) global warming will have a bearing on the wider situation as it would likely induce habitat changes and wider temperature fluctuations, which would favour viral replication in local hosts.[19,20] New Zealand can again be used as an example, where a temperature increase of approximately 0.9^{o}C has been recorded over the past 100 years, as well as reduced frost frequency over most of the country since the 1970s, and a continued retreat of major South Island glaciers.[33]

South Pacific nations due to their close proximity, frequent exchange of goods and high flow of travellers are not independent from each other in regards to infectious diseases. We contend, therefore, that it is becoming increasingly important to support a collaborative integrated approach in the South Pacific for monitoring changes in species distributions and population dynamics of mosquitoes that could constitute a threat to public health, for tracking habitat and climatic changes, and to detect the occurrence of vector-borne diseases. This knowledge could be used to aid intervention strategies and to improve eradication and control programmes.

Essentially everywhere in the world there is an unfortunate reluctance to invest proactively in vector surveillance and prophylactic mosquito control measures in the absence of recognised disease outbreaks. Given the single most important factor determining the scale of an outbreak appears to be community awareness of and involvement in mosquito control,[2] we suggest that a coordinated campaign be initiated in the South Pacific areas most at risk. In New Zealand for instance, it has been estimated that the public health costs from a RRV epidemic in the Auckland region could be tens to hundreds of millions of dollars.[5]

The 2004 tsunami in Southeast Asia illustrates the need for collaborative regional hazard surveillance. Because the area of impact of a tsunami cannot be predetermined, it is necessary to have a surveillance network capable of giving any member country advanced warning. This situation is very similar to that of an introduction of exotic mosquitoes or other arthropod vectors, and of vector-borne disease outbreaks.

A practical example of an effective system is the WHO's Global Influenza Programme, through which an international influenza surveillance system works to reduce the number of people affected by that disease annually and to prepare for future pandemics.[21] Another example is the Global Alliance to Eradicate Lymphatic Filariasis,[22] a multinational and multi-institutional partnership established to prevent parasite transmission, while alleviating the suffering and disability caused by it. In the South Pacific, apart from avoiding human suffering, the prevention of mosquito-borne disease outbreaks would also safeguard the tourism industry in the region, which underpins the economy of many nations.

The costs of programmes to prevent mosquito-borne diseases are relatively small when compared with the human suffering and the human, political and financial costs of the epidemics themselves, and the attendant vector control and other public health measures an epidemic necessitates.[5,23] Many issues need to be addressed in the interest of the individual and of the common good. For example, New Zealand's lack of confirmatory arboviral testing facilities is reason for concern,[3,24] as it means that such tests for the South Pacific are currently only available in Australia—although New Caledonia and Fiji both have testing capability for some viruses.

This need is starting to be addressed through the development of confirmatory assays for arboviruses in New Zealand at the National Centre for Biosecurity and Infectious Disease (NCBID).[25] The establishment of such capability in New Zealand would not only address its own testing requirements, but it would provide an important support facility for many Pacific nations in need of arboviral testing facilities, but which are much less able to afford it.[24]

Such an approach is also consistent with developments in international public health policy,[26] where there is a realisation that to decrease the public health risk to their own populations, higher income countries need to invest in protecting the health of more vulnerable populations in developing tropical countries that can act as sources of emerging infectious diseases.

A recent report from the United Kingdom's House of Lords Select Committee on Intergovernmental Organisations have appropriately recognized the importance of transnational collaborations to tackle outbreaks of infectious diseases.[37]

The report's foreword adequately acknowledges that

> …though Britain and many other countries have effective surveillance systems and though WHO operates a competent international surveillance network, many developing countries are seriously deficient in this respect. On the basis that a chain is as strong as its weakest link, there is a need to direct greater investment into this vital area of global disease control (p.5).[37]

We believe that this statement is applicable to the situation in the South Pacific, and the support of such an approach would greatly strengthen the ability to reduce potential morbidity and mortality from vector-borne disease across the region.

We therefore encourage that extended support is given to the Pacific Public Health Surveillance Network.[27] This will require continued and extended collaboration and funding support between epidemiologists, medical entomologists, non-government organisations and public health departments in New Zealand, Australia, and other South Pacific nations. Such collaboration should also link to international aid eradication programmes being developed in the South Pacific.[35,36]

The adoption of transnational anti-vector measures in the region is also necessary. Furthermore, New Zealand should boost its commitment to establish its own diagnostic reference centre, capable of carrying out all necessary laboratory tests for detection and confirmation of arboviral infections.

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