The possibility of a dengue outbreak occurring in New Zealand

Background

Dengue fever (DF), one of the mosquito-borne viral diseases, has become a leading global health problem, as more than a third of the world's population live in regions at risk for infection (Centers for Disease Control and Prevention, 2015). The World Health Organisation (WHO) suggests that there are about 390 million DF infections each year (95 percent confidence interval = 284–528 million) and about 2.5 percent of those affected die (WHO, 2015a).

Geographically, DF is found in tropical and subtropical regions such as Central and South America, Africa, the eastern part of the Middle East, the Indian Subcontinent, Southeast Asia, south China, northern Queensland and the Pacific Islands (**Figure 1**). The disease is now endemic in more than a hundred countries, putting more than 40 percent of the world's population at risk (WHO, 2015a).

DF is caused by any of four serotypes of the DF virus, specified as DEN-1, DEN-2, DEN-3 and DEN-4 (WHO, 2009a). The disease typically presents with flu-like symptoms, but may develop into the potentially lethal dengue haemorrhagic fever (DHF), which was first diagnosed during DF epidemics in Thailand and the Philippines in the 1950s (WHO, 2009b).

Both DF and DHF are transmitted by DF-virus-infected mosquitoes of the species *Aedes aegypti* (the primary vector) and *Ae. albopictus* (the minor vector) (**Figure 2**). Both species breed in containers.

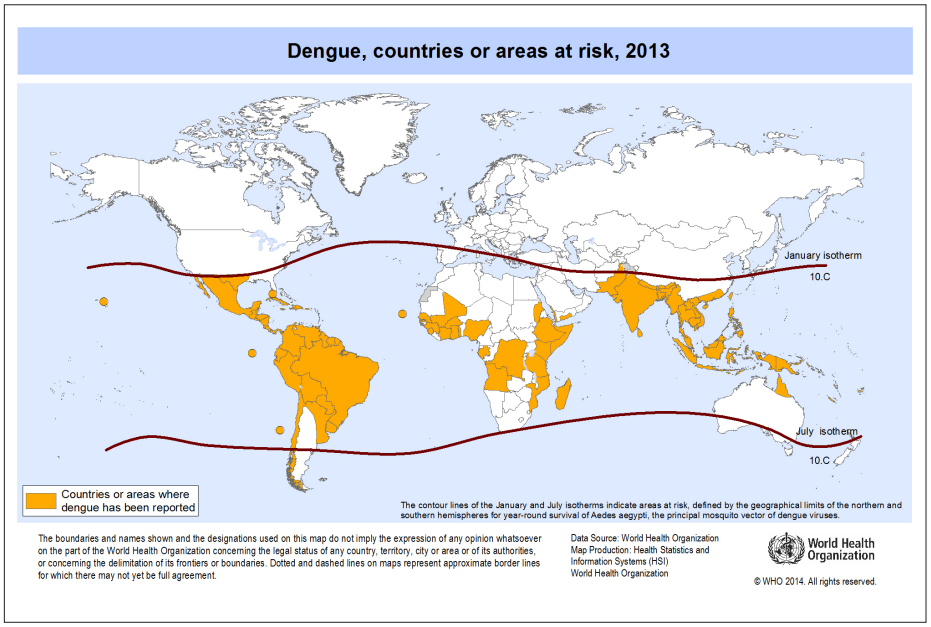

Figure 1: Global DF distribution, 2013 (WHO, 2014)

Figure 2: *Aedes aegypti* and *Ae. albopictus*: two vectors of DF virus (Lounibos & O'Meara, 1999)

An alarming picture

In New Zealand, most DF cases are reported in Auckland, the main gateway for international passengers arriving in the country. Statistics compiled by the Auckland Regional Public Health Service (ARPHS) show that the number of DF notifications is steadily increasing, with all notifications being acquired overseas so far (ARPHS, 2015).

In the Pacific, the DF outbreak situation is regularly updated by ARPHS (ARPHS, 2015). The latest update highlights the alarming situation in Fiji and Samoa: 11 confirmed deaths and 10 000 cases of infection since a DF outbreak started in Fiji in December 2013 (Australian Broadcasting Corporation, 2014; Inter Health Worldwide [IHW], 2014) and 543 confirmed cases had been reported as of 29 April 2015 (ARPHS, 2015). In Samoa, 773 new cases were confirmed between 11 June and 27 September 2015 (ARPHS, 2015).

In Australia, the latest DF outbreak was confirmed as DEN-1 in Townsville, Queensland, on 2 July 2015 (Queensland Health, 2015). It may have shown a new trend, as cases were reported during the winter season, which was previously thought unusual, though all cases are still being reported from northern Queensland. Over the past decade, large outbreaks have occurred in the cities/towns of Cairns, Mossman, Port Douglas, Innisfail, Tully, Townsville and Charters Towers, and in Torres Strait. It is also noted that 1 000 laboratory-confirmed DF cases were reported in Australia in the year to 1 July 2015 (WHO, 2015b).

Table 1: Summary of DF vector interceptions, 2013–2015*

Year	Date	Mosquito species		Specimen type	Risk item/location
		Ae. aegypti	*Ae. albopictus*		
2013	26 May		✓	Larva	Secondhand boat, ex USA, Ports of Auckland
2014	7 January		✓	Larva	Used tyres in container, ex South Korea, Transitional Facility
	20 December	✓		Adult	Baggage tracing unit, Auckland International Airport
2015	31 March	✓		Adult	Passenger's baggage, MPI X-ray unit, Auckland International Airport
	27 June	✓		Adult	Passenger's baggage, Customs inspection area, Auckland International Airport
	7 October	✓		Adult	Fresh pineapple in container, ex Philippines, Transitional Facility

* Source: Updated ARPHS mosquito interception database

To deal with the outbreak, Queensland Health focused on treatment of containers to get rid of the breeding habitat of *Ae. aegypti*. In 2009 alone, 106 000 breeding sites were treated on more than 48 000 properties; more than 6 000 interior surfaces were sprayed and more than 23 600 letters were delivered to Cairns residents to advise them of the risk and the precautions they should take (Montgomery, 2009).

ARPHS roles and responsibilities

DF vector mosquitoes have been targeted for surveillance by ARPHS. Both species are yet to become established in New Zealand but have been intercepted in arriving passengers' baggage at Auckland International Airport, in international cargo from containers at Ports of Auckland, and/or at Ministry for Primary Industries (MPI)-approved Transitional Facilities in the Auckland region. **Table 1** summarises the recent DF vector mosquito interceptions responded to by ARPHS over the past three years.

Routine mosquito surveillance at AIA and POA

ARPHS has been operating a surveillance programme targeting both *Ae. aegypti* and *Ae. albopictus* at Auckland International Airport and Ports of Auckland twice a week for the last decade. Surveillance at Ports of Auckland trapped one *Ae. albopictus* in March 2007.

ARPHS also undertakes monthly mosquito surveys at both these locations and carries out a mosquito survey jointly with MPI and Auckland International Airport at the airport annually.

Efficient responses to suspected exotic mosquito interceptions

ARPHS has responded to a number of suspected exotic mosquito interceptions over the years, largely notified by MPI. MPI quarantine inspectors notify ARPHS of any mosquito-related incidents at the border by following a memorandum of understanding with the Ministry of Health before handing over the responsibility to ARPHS. ARPHS conducts a delimiting survey, removes all potential and apparent mosquito-breeding habitats and arranges for enhanced surveillance around the interception site.

Identification of possible risk factors

It appears that the following five major factors might contribute to future establishment of DF virus in New Zealand:

- climate change may modify the vector mosquito's range of habitat or life pattern;
- there may be unpredictable interceptions of either *Ae. aegypti* or *Ae. albopictus* at the New Zealand border;
- increasing number of passengers are coming from overseas;
- there is ever-growing international trade with Australia, the Pacific countries, Asia and the Americas, which is only likely to increase after New Zealand joins the TPP Deal; and
- there are numerous local breeding habitats that could be used by exotic mosquitoes.

Climate comparison between New Zealand and Australia

Global warming is recognised as one of the major risks, so it may be insightful to compare the temperature regimes of New Zealand and Australia (**Table 2**).

It appears that the daily maximum average temperature for mid-summer in New Zealand cities is much lower than in all the northern Queensland cities where DF outbreaks are frequently declared by Queensland Health.

New Zealand's far cooler climate is unsuitable for the DF mosquito, although this situation could alter with significant climate change (Yu, 2009). However, the climate appears unlikely to change significantly in the near future. There might be some factors associated with ongoing DF outbreaks in northern Queensland (compared with the rest of that state) and even the rest of Australia because historical data indicates that transmission is still limited within Queensland (Russell *et al.*, 2009; Safetravel, 2015).

Discussion

Conditions in New Zealand are unfavourable for the establishment of the DF vectors, *Ae. aegypti* and *Ae. albopictus,* which means the risk of human infection from a locally transmitted source remains very low.

New Zealand has learnt a lot from the incursion of southern saltmarsh mosquito, *Ae. camptorhynchus*, found in Hawke's Bay in December 1998. The 10-year+ high-profile government

Table 2: Comparison of mean maximum temperature in New Zealand and Australian cities and towns

New Zealand cities*	Mean maximum temperature*(°C)	Australian cities/towns†	Mean maximum temperature§ (°C)
Auckland	22.8	Cairns	31.4
Wellington	20.3		
Christchurch	22.6	Port Douglas	30.3
Hamilton	23.0		
Dunedin	18.9		
Palmerston North	20.1–22.9	Townsville	31.3
Tauranga	23.7		
Hastings	24.0	Innisfail	30.8
Rotorua	23.0		
Napier	24.5		
Invercargill	18.5	Tully	31.3
New Plymouth	21.7		
Nelson	22.2	Charters Towers	30.3
Whangarei	23.9		
Whanganui	20.1–22.9	Bamanga	30.8
Gisborne	24.8		
Timaru	20.1–22.9		

* Source: Kay et al., 2013

† All located in northern Queensland

§ Source: Wikipedia, https://en.wikipedia.org/wiki/Cairns

eradication programme has cost more than $70 million.

ARPHS works closely with MPI and major operators at the largest ports of entry, such as Auckland International Airport and Ports of Auckland, and high-risk Transitional Facilities where regular monitoring and treatment of local mosquito-breeding habitats is recommended to reduce the number of mosquito interceptions.

MPI quarantine officers have maintained a high level of competence in keeping exotic mosquitoes out of New Zealand. International shipping containers are fumigated or properly treated whenever a live insect is found, in accordance with MPI standard operating procedures or protocols for pest control.

ARPHS has been running an effective and efficient mosquito surveillance programme for more than two decades while enjoying a sound work relationship with MPI.

Conclusion

Based on the above analysis, there is little likelihood of a DF outbreak in New Zealand in the near future. Hopefully New Zealand can continue enjoying its advantageous position of having no locally transmitted arboviral diseases.

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References

Australian Broadcasting Corporation (2014). 11 people confirmed dead, 10,000 infected in Fiji dengue fever outbreak. http://www.abc.net.au/news/2014-03-12/ra-fiji-dengue-fever/5314610 Accessed 5 October 2015.

Auckland Regional Public Health Service (2015). Dengue Fever, Zika and Chikungunya – Situation Update: October 2015. http://www.arphs.govt.nz/health-information/communicable-disease/dengue-fever-zika-chikungunya#.VhDuEs41BhY_ Accessed 12 October 2015.

Centers for Disease Control and Prevention (2015). Dengue. http://www.cdc.gov/Dengue/ Accessed 21 September 2015.

IHW (Inter Health Worldwide, 2014). Dengue Fever Outbreak in Fiji. https://www.interhealthworldwide.org/home/health-resources/health-alerts/2014/march/20/dengue-fever-outbreak-in-fiji/ Accessed 1 October 2015.

Kay B, Gardner JR, Browne G (2013). How it was before: historical perspectives on receptivity and risk. In: Kay B and Russell RC (eds). *Mosquito Eradication – The Story of Killing Campto*, 1–18. CSIRO Publishing: Collingwood, Victoria, Australia.

Lounibos LP, O'Meara G (1999). Invasion Biology of *Aedes albopictus,* http://fmel.ifas.ufl.edu/research/exotic.shtml Accessed 1 October 2015.

Montgomery B (2009). Dengue (DENV-3) Epidemic Dec 2008–2009 – A North Queensland Disaster. In: *Mosquito Bites in the Asia Pacific* 4(1). 10–17.

Queensland Health (2015). Dengue outbreaks. https://www.health.qld.gov.au/news-alerts/health-alerts/dengue/default.asp Accessed 30 September 2015.

Russell RC *et al.* (2009). Dengue and climate change in Australia: predictions for future should incorporate knowledge from the past. *Medical Journal of Australia* 190,(5), 265–268.

SafeTravel (2015). *Dengue fever, Chikungunya and Zika virus in the Pacific Islands.* https://www.safetravel.govt.nz/news/dengue-fever-chikungunya-and-zika-virus-pacific-islands. Accessed 29 September 2015.

World Health Organisation (2009a). *Dengue: Guidelines for diagnosis, treatment, prevention and control (New Edition).* WHO Press, Geneva, Switzerland, 7.

World Health Organisation (2009b). Dengue and dengue haemorrhagic fever. In: *Fact Sheet No 117.*

World Health Organisation (2014). Dengue, countries or areas at risk, 2013. http://gamapserver.who.int/mapLibrary/Files/Maps/Global_DengueTransmission_ITHRiskMap.png?ua=1 Accessed 21 September 2015.

World Health Organisation (2015a). Dengue and severe dengue. http://www.who.int/mediacentre/factsheets/fs117/en/ Accessed 1 October 2015.

World Health Organisation (2015b), Dengue Situation Update Number 468. http://www.wpro.who.int/emerging_diseases/dengue_biweekly_20150701.pdf?ua=1 Accessed 1 October 2015.

Wikipedia (2015). https://en.wikipedia.org/wiki/Cairns. Accessed 6 October 2015.

Yu S (2009). Biosecurity: Working harder to keep Dengue Vectors under Control in New Zealand. In: *Environmental Health Quarterly Report* 11(4). Auckland Regional Public Health Service, Auckland, New Zealand.

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