WATER SERVICES
ASSOCIATION OF AUSTRALIA

FACT SHEET: MOSQUITO-BORNE DISEASES

Water Sensitive Urban Design and Climate Change

The mosquito life cycle

Mosquitoes are blood-sucking insects that are found all over the world, except in extremely cold regions. All mosquitoes require water for their developmental stages, and different species have evolved to exploit a wide range of water habitats. The larvae of some species prefer pristine 'pockets' of rainwater trapped in the leaves of plants, while others can thrive in highly saline tidal pools or in polluted streams. Mosquitoes also take advantage of man-made water environments, such as rainwater collected in in artificial containers, or water pooled in sewers and stormwater drains. The development of mosquitoes is faster at higher water temperatures, and during a typical Australian summer, the time from hatching of eggs to the emergence of adults may be as little as one week.

In most mosquito species, the females need to feed on the blood of animals or humans 'hosts' in order to produce eggs. Female mosquitoes usually produce three to four batches of eggs during their life and take one blood meal for each batch. However, in some species, the female takes several small blood meals during each egg production cycle. Mosquito species vary in terms of the times of day or night they prefer to feed, and whether they stay in shady areas or venture into the sunlight.

Disease transmission by mosquitoes

When a mosquito takes a blood meal, it first injects saliva that contains anti-clotting substances into the host through a tube in its proboscis. Blood is then withdrawn through a second tube. If there are any pathogens (disease-causing microorganisms, such as viruses) present in the blood stream of the host, these may be ingested by the mosquito. Most pathogens will simply die in the stomach of the mosquito, but some can establish an infection and spread through the body of the insect. If a pathogen is able to infect a mosquito's salivary glands, and grow to high levels there, it may be passed on to new hosts through the injected saliva when the mosquito takes subsequent blood meals. The ability of a mosquito species to support growth of a particular pathogen and transmit it to host animals or humans is called 'vector competence'.

Mosquito-borne diseases in Australia

Locally acquired and imported cases of mosquito-borne infections are covered by the National Notifiable Diseases Surveillance System of Australia. The reporting of cases of these diseases to health departments is required in every state and territory, and information is collected in a national database.

There are four mosquito-borne diseases of public health concern that are endemic to Australia. These infections are maintained by mosquito-animal-mosquito life cycles, but they can also result in infections in humans. However, once infected, humans cannot pass the infection to mosquitoes if they are bitten again.

- **Ross River virus** – this virus causes fever, skin rashes, and arthritis symptoms in multiple joints. Most people recover quickly, but in a small number of individuals, joint pain and fatigue may last for up to a year. Between 4,000 and 5,500 cases are reported each year, but it is believed the incidence of asymptomatic infections is much higher. No fatalities have been associated with Ross River virus infections.

- **Barmah Forest virus** – this causes a similar illness to the Ross River virus, although symptoms are usually less severe. No fatalities have been associated with this infection. Case numbers range from about 600 to 2,000 annually.
- **Murray Valley Encephalitis virus** - the majority of infections associated with this virus cause no symptoms, but about 1 person in 1,000 experiences illness. In a few cases, the virus has caused a serious and life-threatening inflammation of the brain (encephalitis). Usually between 0 and 2 cases of encephalitis due to this virus are reported each year in Australia.
- **Kunjin virus** – this virus is also capable of causing brain infections, but illness is less severe than for Murray Valley Encephalitis virus. No known deaths have been associated with this infection. Only 0 to 2 cases of Kunjin virus infection are reported each year.

In addition, a number of exotic mosquito-borne diseases are detected each year among travellers arriving in Australia. These infections include Dengue virus, malaria, Chikungunya virus and Zika virus. These pathogens have a narrow range of hosts (humans, monkeys and apes) and are maintained largely in mosquito-human-mosquito life cycles in the urban areas of developing countries. They grow to high levels in the human bloodstream and can be transmitted to mosquitoes if an infected person is bitten again.

In most parts of Australia, local transmission of these human-based, but imported, pathogens is not possible because of the lack of competent vector species. However, in far north Queensland, the presence of suitable vector mosquitoes provides conditions where imported diseases can be transmitted locally. Each year, small outbreaks of Dengue fever transmitted by the *Aedes aegypti* mosquito are detected in northern Queensland, and large outbreaks have occurred in 2009 (over 1,000 cases) and 2013 (about 200 cases). Surveillance programs and rapid responses to potential cases of local transmission are needed to minimise the public health impact of such events.

Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) incorporates the beneficial use of stormwater to reduce adverse ecological impacts, reduce potable water demand, and to improve the amenity of the urban environment. Components of WSUD include rainwater tanks, rain gardens, swales, sediment basins and constructed wetlands. Those elements that are designed to retain water for more than two to three days, namely rainwater tanks and constructed wetlands, have the potential to provide breeding sites for mosquitoes.

Australia has seen a great increase in the number of households with rainwater tanks in recent years, and surveys have indicated that a small percentage of tanks are providing breeding sites for mosquitoes. To date, no apparent impact on vector-borne disease rates has been observed, but historically, mosquito breeding in rainwater tanks was associated with the transmission of the Dengue virus in northern Australia. Therefore, ongoing surveillance is warranted to assess whether rainwater tanks contribute significantly to disease transmission risks, and how such risks may be mitigated.

Current evidence does not suggest that vector-borne disease transmission has been associated with constructed wetlands; however, active monitoring and management is needed to control both nuisance biting mosquito species and those that are able to transmit infections. Such programs need to be grounded in a good understanding of local mosquito ecology. Evidence also indicates that healthy wetlands with high biodiversity are associated with lower numbers of mosquito vector species and lower human disease risks.

Climate change

Rainfall and temperature are key factors affecting mosquito breeding activity, and it has sometime been

predicted that climate change will lead to large increases in the geographic range of mosquito vectors and consequent increases in disease transmission to humans. However, the population dynamics of mosquito species are extremely complex, and local variations in environmental conditions, host animal density and human behaviour also play a role in determining disease rates. Consideration of these factors, together with historical knowledge of mosquito-borne disease patterns in Australia, indicates that while localised increases or decreases may occur as a consequence of climate change, the change in overall disease rates is likely to be small.

Other threats

Currently, the possible introduction of the Asian tiger mosquito (*Aedes albopictus*) is regarded as the greatest threat relating to vector-borne diseases in Australia. This mosquito is tolerant of cool climates, and bites aggressively during both day and night. It can transmit several important pathogens, including the Dengue, Chikungunya and Zika viruses, and possibly the Ross River virus. This species has become established in the Torres Strait Islands and has been accidentally imported in cargo at major Australian ports on numerous occasions, but has been eradicated by quarantine measures. If it were to become established on the Australian mainland, it could enable the local transmission of imported diseases in the southern states, and possibly increase the risks of Ross River virus transmission in both rural and urban areas.

Other possible threats include the introduction of exotic infections (such as the West Nile virus) which may be able to become established in local host animals, and the risk of local viruses mutating to more virulent forms (as has occurred overseas with the Chikungunya and the West Nile viruses).

More information is available from your State or Territory Health Department.

References

Carver, S., D. P. Slaney, P. T. Leisnham and P. Weinstein (2015). Healthy wetlands, healthy people: Mosquito borne disease. In: Wetlands and Human Health: p95-121. Springer Science+Business Media. ISBN 978-94-017-9608-8

Russell, R. C. (2009). Mosquito-borne disease and climate change in Australia: time for a reality check. Australian Journal of Entomology 48(1): 1-7.