

# Going global: the battle against emerging disease

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## Lessons for Australia: Biosecurity Year in Review 2008

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After weathering a biosecurity 'storm' in 2007 caused by the horse flu outbreak, Australian horses were again thrust into the spotlight this year when Hendra re-emerged, claiming the lives of nine horses and a local veterinarian.

Worldwide, vector-borne diseases such as dengue and chikungunya continued to spread, and bluetongue was seen for the first time in sheep and cattle herds in northern Europe. In the past two decades, 75% of emerging infectious diseases have been zoonoses – infections transmitted from animals to humans – and most have originated from wildlife.

In a globalised world there is an ever-greater chance of contact with emerging pathogens. The speed and range of international trade and travel is unprecedented; unplanned urbanisation and land-clearing are at an all time high. Escalating population density and intensive farming practices are increasing contact between humans, livestock and wildlife. Changing climates are also driving variations in vector populations and disease patterns, and could support the global march of vectors like mosquitoes and biting midges.

In Australia, the complex interaction between bats, horses and humans in the Hendra outbreak is a timely reminder that the health of humans, livestock and wildlife are inextricably linked. Along with many leading animal and public health authorities worldwide, the Australian Biosecurity CRC partnership supports the 'One Health' view that protecting and promoting the wellbeing of all species is essential for managing new and emerging diseases globally.

### Australia an EI-free zone

The Australian horse flu outbreak is officially over.

On 30 June 2008, Australia was declared free of horse flu. It took 125 days to control the outbreak; more than 10,000 infected premises' were involved, and approximately 76,000 horses were infected and 281,000 horses vaccinated.

Spreading like wildfire in NSW and Queensland in 2007; equine influenza is the most devastating exotic disease outbreak in Australia's history. The disease response alone cost \$100 million, and horse and related industries lost an estimated \$1 billion.

Early diagnosis and movement restrictions stopped horse flu in its tracks and risk-based zoning and vaccination ensured that the virus never made it out of New South Wales and Queensland. Australia can now count itself as one of the few countries that have successfully eradicated the disease.

The question remains, how do we prevent another outbreak? Debate continues over ongoing vaccination and its effect on future control efforts. Monitoring will continue

for signs of the disease and it is expected that international recognition of proof-of-freedom from EI will occur in December 2008, twelve months after the last confirmed case.

Though horse flu is not usually fatal in horses and does not cause disease in humans, the outbreak is a timely reminder that, even with Australia's stringent biosecurity measures, protection from exotic disease is not guaranteed. If the same scenario occurred with a highly contagious human disease, or one that is transmitted from animals to humans, it would be a public health disaster.

### **Hendra reappears in Queensland**

In July 2008 the deadly Hendra virus re-surfaced in Queensland, with two unrelated outbreaks at properties in Brisbane and Proserpine.

The Redlands Veterinary Clinic in Brisbane was the worst hit; nine horses and two workers at the clinic were infected. Local veterinarian Ben Cunneen died as a result of the infection - the first fatal human case of Hendra since 1995.

Hendra first came to the attention of scientists in 1994, following an outbreak at a horse training facility in Hendra, Queensland. Since then there have been 10 outbreaks in horses, on average one a year. Australia is the only country known to harbour Hendra virus; which is carried by flying foxes.

The 2008 outbreak was unusual though; infected horses had primarily neurological symptoms, with none of the usual respiratory signs of Hendra infection.

"I received a call about some unusual horse deaths at the Redlands Vet Clinic," says Dr Ron Glanville, Chief Veterinary Officer from Biosecurity Queensland. "We suspected a herpes virus at that stage; the symptoms weren't typical of Hendra. But as part of our investigation into unusual deaths we do a 'rule out' test for Hendra virus, and we got a positive result."

Further testing revealed a new, slightly different, strain of Hendra.

"From past studies we predicted that variants of Hendra would exist," says Dr Linfa Wang, of CSIRO's Australian Animal Health Laboratory. Nipah virus, Hendra's 'cousin' found in South and South-East Asia, also exhibits genetically variable virus strains. "The viruses responsible for the 2006 and 2008 outbreaks are genetically different to the original strain from 1994 but they are still definitely Hendra."

Through extensive studies carried out by the Australian Biosecurity CRC partnership, we now know that all four flying fox species in Australia are able to carry Hendra, and between 10 and 40% of bats in a colony will be exposed to Hendra at some point in their lives. Yet, they show little to no sign of clinical disease.

"In horses and humans Hendra replicates to very high levels," says Dr Wang. "But viral loads are very low in bats – they may have a different way of handling the infection."

So far, there have been no cases of direct transmission from bats to humans and the only human cases have been directly attributed to transmission from sick horses. Researchers suspect that horses pick up the virus from feed contaminated with flying fox secretions – urine, saliva and even birthing fluids.

According to Dr Wang, bats usually maintain virus at such low amounts that spill-over is a very rare event. So what is triggering these spill-over events? Dr Wang hypothesises that – just as humans become ‘run down’ and predisposed to infection – bats under stress due to starvation, habitat loss or even pregnancy may be more susceptible to Hendra virus. And they are coming into increased contact with animals and humans as they colonise suburban and semi-rural areas in search of food.

Thankfully, Hendra is not a very contagious virus, certainly much less transmissible than influenza or even SARS. But a new variant could be different. “This is what we are afraid of,” Dr Wang admits. “SARS is a more contagious virus, it caused worldwide panic, but mortality in humans is only 10%. Hendra infection in humans results in 50% mortality. If a more contagious strain appeared, we would have a serious and potentially global problem on our hands.”

In the meantime, state and federal departments trying to manage and control Hendra outbreaks could find that uncharacteristic symptoms hinder these efforts, particularly if they are relying on disease reporting from owners and regional vets. Biosecurity Queensland has recently updated Hendra guidelines to include a broader range of symptoms.

“Everyone involved with horses, particularly vets, need to be very aware of the disease, practice appropriate biosecurity measures and always wear personal protection,” Dr Glanville states. “Because it is so rare, people get a bit blasé, and could be exposed before even thinking about Hendra. Symptoms can vary, so we need everyone who works with horses to be on the lookout for *any* unusual disease.”

### **Asian tiger mosquito on the prowl**

The Asian tiger mosquito (*Aedes albopictus*) may not have made a home in mainland Australia yet, but it isn’t for lack of trying.

Though native to South-East Asia, the Asian tiger mosquito has been on a ‘global conquest’ – establishing populations in previously uncharted territories, including the eastern Pacific, the Americas, Africa, Europe and the Middle East.

“They lay eggs in containers – tyres, pot plants – anything that holds a little water,” says entomologist Dr Andrew Van den Hurk of Queensland Health’s Forensic and Scientific Services. “Virtually every time the Asian tiger mosquito has appeared in a new region it has been linked to freight shipments, including ‘lucky bamboo’ plants in California, and used tyres in Europe and South America.”

Mainland Australia has so far resisted colonisation, but authorities have intercepted at least 28 incursions in the last 11 years. It will be an ongoing battle, as the species

is now well established in Papua New Guinea and the Torres Strait islands, with populations found on at least 10 of the 17 inhabited islands.

“The Asian tiger mosquito is a real pest, the literal ‘BBQ stopper’,” says van den Hurk. “It is a vicious biter and attacker – day or night – and if that’s not bad enough, it’s also a major vector for chikungunya and dengue viruses.”

Previous experience tells us that colonisation by an exotic mosquito species is both possible and perilous. Our resident dengue mosquito (*Aedes aegypti*) – introduced to Australia in the mid-19<sup>th</sup> century – is responsible for annual outbreaks of dengue in Far North Queensland, most recently in December 2008 where 34 people have already been infected.

“Dengue outbreaks in Australia can always be traced back to infected travellers arriving from areas where the disease is endemic,” says van den Hurk. Fortunately the limited habitat range of the mosquito vector restricts the spread of the virus, and it can be wiped out by extensive (but costly) elimination programs.

However, changing climates could cause the dengue mosquito to extend into more populated and urbanised areas. Some studies have suggested that dengue could spread as far south as Sydney if temperatures in Australia increased by 2-3 degrees Celsius in the next 90 years.

Chikungunya cases in Australia have also been limited to international travellers, and so far there has been no local spread of disease. But this could be pure luck. Dr van den Hurk, in a study supported by the Australian Biosecurity CRC, discovered that Australian mosquito species are able to be infected with, and transmit, chikungunya virus.

“We do have native mosquitoes in Australia that could transmit chikungunya,” van den Hurk admits, “but the Asian tiger mosquito is a more competent vector, is better at transmitting virus and is more cold tolerant.” If it successfully colonised the more populated southern regions such as Brisbane, Sydney or Melbourne – areas that are international travel hubs – van den Hurk says, “we could have a real public health problem on our hands.”

Worldwide, there have been significant increases in mosquito-borne diseases over the last 30 years with dengue and chikungunya running rampant in many tropical and developing regions.

“There are a whole host of human activities that are contributing to outbreaks,” says van den Hurk. “International travel is the big one – you get bitten in Thailand, hop on a plane, and 9 hours later you and dengue or chikungunya are here in Australia.”

Deforestation, agricultural land use, and changing water management practises have all been linked to mosquito-borne disease outbreaks around the world. Urbanisation is another huge factor, especially for dengue in South-East Asia and chikungunya in India.

“Unplanned urbanisation with little to no infrastructure is the ideal environment for the proliferation of the Asian tiger mosquito,” agrees van den Hurk. And while this may not be a direct problem for Australia, it is for many of our closest neighbours.

## Bluetongue spreading through Europe

Another emerging disease that may be linked to changing climate is bluetongue.

Recently surfacing in northern Europe for the first time, bluetongue is a non-contagious disease spread by biting midges (*Culicoides sp.*). The disease is potentially fatal, especially in sheep; more virulent strains can also cause disease in cattle, goats and other ruminant animals.

2006 brought an unusually warm summer and mild winter to Europe, and the first ever detection of bluetongue virus in northern Europe. Outbreaks occurred in the Netherlands, Belgium, Luxembourg, western Germany and north-eastern France. In 2007 and 2008 bluetongue virus has continued to infect herds in northern Europe and the UK.

Bluetongue has been endemic to the warmer southern regions of the continent since 1998, a spread widely attributed to movement of the major bluetongue vector into the region due to climate change. Northern Europe remained free of disease until the recent outbreak, when milder climates may have created favourable conditions for native vector populations to spread the introduced virus. There is also concern that infected midges could even be surviving through the winter to transmit virus the following year.

At least 24 different strains or serotypes of the virus have been described, on almost every continent (including Australia), but they vary widely in their ability to cause disease.

“Australia’s status as free from bluetongue disease is very important to maintain our position as one of the world’s leading exporters of sheep and cattle,” says Professor John Edwards, Dean of Veterinary and Biomedical Sciences at Murdoch University, WA. Professor Edwards explains that, although some bluetongue serotypes in Australia can cause disease in sheep, a nation-wide zoning system ensures that the virus and vectors do not come into contact with sheep populations. Cattle are unaffected by the bluetongue serotypes in Australia. “So even though the virus is present in some areas, bluetongue disease is still considered an exotic disease for sheep in Australia.”

The bluetongue strains currently circulating in northern Europe have never been detected before on the European continent. Serotype 8, first detected in 2006, and more recently serotype 6 (2007/08) in fact resemble the more virulent serotypes that are circulating on the Sub-Saharan continent. In 2008, bluetongue serotype 1 was also discovered in northern Europe, and imported cases were reported in the UK in November.

Researchers are still unsure of exactly how these new serotypes arrived in Europe, but the suggestion is that it could be a combination of incursions at seaports from global trading and a warming climate allowing the spread of vectors.

“This is a wake up call for Australia,” Edwards says. “We need to be vigilant about detecting any changes in viruses and vectors within Australia and also in our neighbouring countries.”

## Covert koala killer

Invasions aren't all on a global scale – a recent virus afflicting Australia's wildlife population is staging war on a microscopic level.

Koala retrovirus has been wiping out koalas in record numbers on the Australian mainland. The surprise twist is that the virus appears to be transitioning from an infectious external virus to an integrated part of the koala genome. That means that although virus is still being passed from koala-to-koala, the virus is also passed in genetic material from parent-to-offspring.

The virus triggers an AIDS-like illness that causes immune system deficiencies, leukaemia and other cancers in koalas, and is invariably fatal. It has also been linked to susceptibility to Chlamydia infections that have been devastating koala populations.

Researchers found that the virus started circulating in koala populations about 100 years ago. After coming close to extinction due to hunting in the 19<sup>th</sup> century, small numbers of koalas were relocated to islands off the coast to preserve the species. Koalas on Kangaroo Island, off the South Australian coast, remain free from disease, yet on the mainland infection rates are soaring. Almost 100% of koalas in Queensland are infected with koala retrovirus; this rate gradually declines as you travel south along the east coast, to about 25% in Victoria.

The virus is likely to have made a trans-species jump. Repeated incursions of Asian rodents into northern Australia, over thousands of years, is suspected to be the source of the virus in koalas.

## Also on the radar in 2008

In the Sub-Saharan region, a new haemorrhagic viral disease was discovered in southern Africa in September 2008. A Zambian tour guide died, and four healthcare workers who came into contact with her were infected during the outbreak. Three died; the fourth responded well to treatment and was cleared of the virus in mid-November.

Tests revealed that it was a new arenavirus, the first to be found in southern Africa. The source of disease is also likely to be rodents; the natural hosts for most arenaviruses which, like flying foxes, can carry the infection without any signs of disease. Humans are usually infected after coming into contact with urine, saliva, blood or faeces of an infected mouse, or dust contaminated with the virus. Most arenaviruses are found in South America; Lassa Fever, the only other arenavirus recorded on the African continent, is limited to West Africa.

Officials said the virus has been contained, but continue to monitor more than 100 people who came into contact with the virus.

A common bacteria carried by pigs is becoming a serious occupational hazard for Australian piggery workers. In 2008, two cases of infection with *Streptococcus suis* were reported in New South Wales. One patient, a 46-year-old-woman, lost more than 20 kilograms before she was diagnosed, and required a heart valve replacement.

Only two other cases have previously been reported in Australia; both were infected through occupational exposure. Pathogenic strains of *Strep. suis* can, in humans, cause toxic shock syndrome, heart valve infections, meningitis and pneumonia. Pigs often carry the infection without symptoms.

In 2005, an uncommonly large outbreak occurred in Sichuan province, China. From mid-July to the end of August, 215 people were infected, almost exclusively through unsafe backyard slaughtering practices of sick pigs.

### **Global ‘hot-spots’**

International air travel, global trade, urbanisation and land-clearing are providing a super-highway for the speedy transmission of emerging infectious diseases around the world. Changing climates are altering vector distribution and movements, changing disease patterns in old territories and allowing pathogens to emerge and move into new, naive territories.

In biosecurity terms, the aim is pre-emption and prevention. And according to Dr Peter Daszak of the Consortium for Conservation Medicine in New York, the key is location, location, location.

“We’ve developed an ‘earthquake zone’ style map for emerging diseases – it shows us which countries are most likely to be on the front line of an emerging pandemic. We now have a new way to predict the places from where the next HIV, SARS or avian influenza is likely to emerge,” says Daszak.

The future is in pin-pointing global ‘hot-spots’ and using targeted ‘smart’ surveillance. Daszak argues that we are ‘wasting’ the bulk of the research effort by focussing our resources on the countries *least* likely to foster a new SARS or HIV.

“If we’re going to do business in one of these hot-spots, whether that’s agriculture, trade or travel, we need to have some mechanisms in place to pre-empt an emerging disease. This can be surveillance of people, domestic animals or wildlife – preferably all three!”

And there is an important warning for Australia.

“Our risk map shows that Australia is surrounded to the north by a ‘ring of fire’ – countries that are some of the hottest of the hot-spots,” Daszak says. “Australia needs to be forward thinking in its approach to biosecurity risk.”

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