Australian Biosecurity Forum

Parliament House, Canberra
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Hosted by the Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease

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Introduction

The Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease held a biosecurity forum at Parliament House in Canberra on 16 September.

The aims were:

- to discuss the current and emerging biosecurity threats to Australia and our region
- to celebrate and enhance the national collaboration on biosecurity that the CRC has facilitated over the last five years.

Twelve speakers were invited to talk on a wide range of topics.

The following is an account of the ideas and issues raised during the forum. It may be reproduced with acknowledgement to the author, Margie Beilharz, Science in Public. Photos of the speakers are also available.

The increasing threat from infectious disease

Each year we discover new infectious diseases—many of them are fatal and many are beyond the scope of medicine to cure, especially in developing countries.

The threats from these diseases and recommendations for action were presented at a recent forum on biosecurity in Australia attended by scientists, livestock producers and senior government representatives.

The forum was hosted by the Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease. The Centre brings together academics, health professionals and scientists with the aim of protecting Australia's public health, livestock, wildlife and economic resources by strengthening our capability to respond to emerging diseases which affect national and regional biosecurity.

The list of infectious diseases of concern to Australia is a long one. It includes:

- avian influenza and severe acute respiratory syndrome (SARS), which have been global news in the past few years
- the Hendra virus, which recently killed a Queensland vet
- drug-resistant bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA)
- livestock diseases such as foot-and-mouth disease and bluetongue virus
- wildlife diseases such as the chytrid fungus, which is implicated in the decline of frog populations worldwide, and devil facial tumour disease, which is devastating Tasmanian devil populations.

On average, the past three decades have seen the emergence of one new infectious disease a year

Some of these diseases are newly discovered. Some are known diseases in a new form that is more dangerous, such as a virus of livestock which changes to become able to infect humans, or transmit from person to person. On average, the past three decades have seen the emergence of one new infectious disease a year said Julie Hall of the World Health Organisation, but the incidence of new events is rising. And this is not just an outcome of increased awareness or reporting said Peter Daszak, from the Consortium for Conservation Medicine.

Moira McKinnon, from the Australian Biosecurity CRC, noted that drastic control measures used previously are no longer an option. For example, last century we fought diseases such as malaria and yellow fever with widespread use of DDT to control the mosquito vectors carrying the disease. However, DDT was banned due to its toxic side-effects and the mosquito populations have bounced back. This is one of the reasons that the rate of malaria infections worldwide is now three times as high as that in the 1960s. The world needs to develop systems of control that do not harm the environment and other species.

Infectious disease agents are also a potential biological weapon for terrorists. Bioterrorism is defined by Lyn Gilbert, from the Institute of Clinical Pathology and Medical Research at Westmead Hospital, as "the malicious use of pathogens or a toxin, whether natural or engineered, to evoke extreme fear in a population in order to achieve political objectives". Bioterrorism is one component of the threat from infectious diseases.

The rising incidence of new infectious diseases is due to increases in:

- the rate at which new diseases are emerging; and
- the likelihood that an emerging disease will spread.

Emergence

The forum heard that increases in population size and the misuse of antibiotics both contribute to the emergence of new diseases.

As population size and density increases, particularly in developing countries, humans, livestock and wildlife are living in ever closer proximity, providing more opportunities for disease spread from person to person and from animals to humans. Nipah is one example of a virus that crossed the barrier from animals to humans—when it was first discovered, the virus spread from bats to pigs and from pigs to humans. The closer the contact between people in a community, and with their livestock, the more likely it is that diseases will spread throughout the population.

To make matters worse, we are losing the ability to treat some previously 'manageable' diseases.

"Antibiotics are the wonder drugs of last century," said Peter Collignon, Director of Microbiology and the Infectious Diseases Unit at Canberra Hospital. But overuse and misuse have brought us to the situation where we are scared to go to hospital in case we catch a disease that is very difficult to treat, like methicillin-resistant *Staphylococcus aureus* (MRSA).

Increases in population size and the misuse of antibiotics both contribute to the emergence of new diseases

Bacteria multiply every 15-20 minutes and, as Collignon put it, "they have sex without condoms" so genetic material can be exchanged, even between species. The widespread use of antibiotics, in both humans and in livestock production, has lead to increasing numbers of resistant bacteria, such as MRSA and fluoroquinolone-resistant *E. coli*.

Yet Collignon reported that preventive measures can be very effective, even simple actions like washing hands between attending to different patients in hospital. In Perth, where there has been a major campaign to lower MRSA rates, the chance of a hospital-acquired *Staphylococcus* infection being multi-drug resistant is around 2%, compared with 22% in Melbourne and 30% in Sydney. Much higher rates again are found in developing countries.

In Australia, the rate of fluoroquinolone-resistant *E. coli* is relatively low. And as Collignon observed, "It is not coincidental that we are one of the few countries that do not use fluoroquinolone in the production of food." He would like to see critically important, 'last resort' antibiotics used only in the treatment of human disease, as well as education to prevent misuse, improved infection control and increased surveillance. He also stressed the need to research and develop new antibiotics for use in the event that our current drugs become ineffective.

Spread

The forum heard that newly emerging diseases can be transported by human travel or trade.

Many of the biosecurity threats to our nation come from outside our borders

"Two million people visit Australia each year," said McKinnon, and they have come from all over the world.

Large scale movement of people, livestock and goods, and the unfettered movement of wildlife (including through illegal trade), allows diseases to travel quickly from country to country and continent to continent. In Australia, it means that we cannot consider domestic issues alone in our plans for responding to emerging diseases. Many, but not all, of the biosecurity threats to our nation come from outside our borders.

Cultural factors can also play a part in the spread of disease. Daszak explained that in Bangladesh, Nipah virus can spread from person to person, primarily because of the custom of family members directly caring for and nursing sick relatives and consequent exposure to secretions allowing transmission of the virus.

Diseases can even spread without direct human involvement, as a result of environmental change. A changing climate could result in an increase in emerging infectious diseases due to the spread of pathogens, disease hosts and vectors beyond current environments and disease hotspots. Hall warned that an increase in the prevalence of natural disasters, which is one of the likely consequences of climate change, could increase the risk of disease outbreaks associated with poor hygiene and lack of food in disaster areas.

An increase in the prevalence of natural disasters could increase the risk of disease outbreaks

There is the risk that diseases such as chikungunya and new strains of bluetongue may flourish in Australia as our climate changes. McKinnon discussed the threat to Australia of the introduction of chikungunya—a virus that has a surprisingly low profile given that is has infected millions of people and killed many hundreds. It is endemic in Africa and South-East Asia, and there has been one outbreak in southern Europe.

We don't yet have chikungunya in Australia, but we do have one of the known host mosquitoes, *Aedes aegypti*. The virus is also carried by the Asian tiger mosquito, *Aedes albopictus*, a very aggressive species that can carry a number of serious diseases, including yellow fever and dengue. *A. albopictus* have been found in the Torres Strait and changing climates could lead to establishment of the species on the Australian mainland.

Bluetongue is a viral disease carried by midges which bite and infect livestock, particularly sheep. Bluetongue has become a serious problem for European livestock, as it spread north into Europe in the past two decades said Martyn Jeggo, Director of CSIRO's Australian Animal Health Laboratory. This is a result of the warmer and milder winters of recent years, which are more suitable for the survival of midges that can transmit bluetongue virus.

Bluetongue virus was found in midges in Australia in 1986, but we don't see cases of bluetongue disease in sheep in Australia. This is primarily because the midges that can transmit the virus are found in warm and wet areas of north and north-eastern Australia, while sheep are predominantly farmed in the hotter and dryer inland.

As temperatures in Australia rise, and rainfall patterns alter, we may find that the midges spread to where the sheep are. Then we'll have to deal with bluetongue in sheep-producing areas for the first time.

Though it may seem like a recent occurrence, humans also have a long history of spreading disease by bioterrorism, said Gilbert. In the 14th century the Mongol army catapulted plague-infected corpses into cities to spread disease and defeat the inhabitants. In a case of recent and deliberate bioterrorism, anthrax spores were sent to politicians in the US in 2001 following the terrorist attacks on New York and Washington; five people died and the scare caused huge upheaval.

The fear of white powder then spread to Australia where, in just a few months, authorities were notified of over 1200 cases of suspected anthrax powder, all of which turned out to be mistakes or hoaxes. These cases stretched the ability of police, public health authorities and laboratories to respond.

Economic and social impacts of disease

Infectious disease is not only a health issue; it can also have great economic and social impacts—in terms of both emergency responses and preventive measures. In the last fifteen years, livestock diseases have cost $US80 billion worldwide. The response to SARS, a human disease, has so far cost at least $US50 billion; Australia spent $930 million on SARS even though it never reached our shores. This reinforces the extent to which we are affected by diseases occurring elsewhere in the world.

Response efforts need to take into account the socio-economic impact of both the disease and the response. Hall agreed that responses to significant disease threats, such as the widespread slaughter of livestock, could be very costly, especially in developing countries. "Prevention is always cheaper in the long run than treatment. But it is possible to invest in the control of a particular disease whilst still ensuring that capacity is strengthened across the board," she said.

Bioterrorism, or even the threat of bioterrorism, often causes economic and social effects that far outweigh any actual health impact. But that is, of course, the aim of bioterrorism, Gilbert emphasised.

Solutions

Speakers at the forum provided many recommendations for managing emerging infectious diseases.

A good model: equine influenza

There are some success stories. Veterinary epidemiologist Nigel Perkins, Director of AusVet Animal Health Services, reported that Australia's response to the equine influenza was highly effective—offering both invaluable experience and important lessons for the future.

Over approximately 125 days, equine influenza was diagnosed, contained and eradicated in Australia, despite many people believing that efforts would fail. There were, after all, over 9,000 infected premises with 75,000 horses exposed, and the outbreak was fast and

Over approximately 125 days, equine influenza was diagnosed, contained and eradicated in Australia

widespread throughout New South Wales and Queensland.

How was it done?

Perkins told the forum that the response was a coordinated, multi-agency effort with a high level of commitment from the community and industry. Movement control and biosecurity were key strategies, supported by implementation of rapid diagnostic tests for detecting infected horses and vaccination programs.

Although many scientific questions and challenges remain, equine influenza was eradicated from Australia and the situation provided invaluable experience for all involved in combating similar outbreaks in the future, even for other diseases. But there were huge socio-economic impacts, which are still being felt by businesses and individuals.

'One health' approach

Many speakers at the forum emphasised the need to take a 'one health' approach to dealing with emerging infectious disease, recognising the inextricable link between human, livestock and wildlife health. Three quarters of new and emerging diseases in humans have links with animals: as a source or playing a role in transmission. Therefore, researching and managing animal diseases must be an integral component of any public health program.

Three quarters of new and emerging diseases in human have links with animals

Wildlife diseases can also have broader ecological implications, said Karrie Rose, from the Taronga Conservation Society Australia, particularly if they lead to the dramatic loss or extinction of a species. For example, if we lose Tasmanian devils to devil facial tumour disease we will lose one of the barriers to the establishment of a fox population in Tasmania. That would have a devastating effect on many native species, as we have learned, to our cost, on the mainland.

So, when managing diseases in wildlife that may lead to the devastation of a population or even the extinction of a species, Rose emphasised that simply dismissing it as a natural occurrence or of little importance to human health is not realistic.

Assess risk

Put simply, we determine the risk of an activity by assessing the likelihood of it occurring along with the consequences if it does occur. However Ron Glanville, Chief Biosecurity Officer and Chief Veterinary Officer at Biosecurity Queensland, says that our perception of risk is often influenced by an 'outrage' factor—diseases that result in human death will get a huge and, it could be argued, disproportionate amount of attention.

Mark Burgman, Director of the Australian Centre of Excellence for Risk Analysis, studies risk perception—based not just on the technical assessment of risk, but also on the factors that influence our evaluation of risk and the decisions we make. For example, how do we weigh up the risks and benefits associated with international trade?

"Unfortunately, in uncertain circumstances we tend not to make effective judgements," Burgman said. "Our decisions are coloured by factors such as our understanding of the issue, personal experience, our level of personal control, how dreadful the outcome is and how visible the threat is."

To support this, Burgman cited data from the US following the terrorist attacks in September 2001. In the months following the attacks, many people chose to drive rather than fly—perceiving the risk of air travel as much greater than travelling by car. However the number of people killed in car accidents increased, due to more people driving, resulting in more extra deaths than were caused by the terrorist attacks.

Only 8% of Biosecurity Queensland's expenditure is on prevention, while 50% is on disease response

Perhaps inevitably, resources tend to be focussed on putting out the bushfires–that is, responding to the latest outbreak rather than trying to prevent it. Glanville estimated that only 8% of Biosecurity Queensland's expenditure is directed toward disease prevention, while 50% is spent on disease response.

Use good science

So to manage disease threats well we have to methodically assess risk; then use good science to aid in prevention and response.

When avian influenza hit the news, the US government approached it entirely the wrong way, says Daszak. They focussed on the flight paths of migratory birds as being the major risk factor. However scientific research and analysis performed at the Consortium for Conservation Medicine showed that migratory birds represented a very low risk for introduction of avian influenza to the US. A much greater risk came from the poultry trade—not direct trade to the US, but rather disease spread from Canada and Mexico, which were less rigorous in their trade practices with countries with a history of avian influenza.

When the Consortium's results were published in the Proceedings of the National Academy of Sciences, the US government changed its surveillance to focus on the more significant threats.

Modelling projections can also be used to determine future disease patterns, for example the effects of climate change, or to select suitable areas for livestock production.

Regional capacity building

Australia is an island but, as we saw earlier, that doesn't give us protection from offshore infectious diseases. As John Edwards, Dean of the School of Veterinary and Biomedical Sciences at Murdoch University, said, "We can't rely on a 'fortress Australia' approach alone."

Preventive and response measures have to go beyond Australia's borders if we are going to avoid, or manage, emerging infectious disease threats. One of Australia's major thrusts, said Andy Carroll from the Australian Government Department of Agriculture, Fisheries and Forestry, who stood in for Tom Aldred, is to increase the capacity of our neighbours in the Asia-Pacific region to detect, diagnose and respond to emerging diseases.

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Carroll discussed the work that the Australian Quarantine and Inspection Service's Northern Australia Quarantine Strategy is doing in neighbouring countries like Papua New Guinea to

build technical capacity and enhance infrastructure. This will help them to: more accurately determine the status of diseases in the country; improve their disease status; and apply appropriate quarantine measures to prevent additional diseases arriving.

The next big one

So what is the major emerging infectious disease threat? The consensus at the forum was that though we know 'the next big one' is looming, we can't predict what it will be—it could be an existing disease or it could be something completely new.

We need to expect the unexpected

"We need to expect the unexpected," said Rose.

What we have learnt from previous outbreaks is that we need to build our capacity, and the capacity of the region, to respond effectively to whatever disease arises. This requires an investment in knowledge and infrastructure, and that's where the Australian Biosecurity CRC has an important role.

Stephen Prowse, CEO of the Australian Biosecurity CRC, said that it is not a lack of data that is a problem. Rather, we have so much information to sift through that it is difficult to manage.

At the forum, Prowse launched a new initiative, the Biosecurity Risk Intelligence Scanning Committee (BRISC), which will help to deal with the management of information on emerging disease threats. BRISC will provide a new capability to scan data and make assessments of specific diseases, and will help the CRC determine priorities for research and action.

The fight against infectious disease will always be an ongoing and uphill battle. But by preparing and arming ourselves well, we can maximise our chances of successfully controlling the major threats to Australia and our region.

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