

Strategies for enhancing Australia's capacity to respond to emerging infectious diseases

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Summary

Along with many other countries, Australia faces significant threats from emerging infectious diseases that emanate from wildlife or involve a wildlife vector. A salient example of such a disease is Hendra virus. The outbreaks of Hendra virus in 2008 highlight the critical need for a 'One Health' approach to the management of emerging infectious diseases. In Australia, cross-sectoral and cross-jurisdictional 'One Health' approaches to the improved management of emerging infectious disease are being undertaken. These include improved management and sharing of biosecurity information, the joint cross-sectoral development of laboratory infrastructure, 'One Health' policy initiatives and 'One Health' approaches to disease research. These initiatives are enhancing Australia's disease response capacity and capability as well as supporting efforts to better control emerging infectious disease in the region.

Keywords

AusBIOSEC, Australia, Biosecurity, Disease, Emerging, Health, Hendra, Information, One Health, Public health, Research, Trans-discipline.

Strategie per migliorare la capacità di risposta dell'Australia alle malattie infettive emergenti

Riassunto

Come molti altri paesi, l'Australia è esposta a minacce significative legate alle malattie infettive emergenti che hanno origine dagli animali selvatici o si trasmettono per mezzo di un animale vettore. Un esempio di questo tipo di patologie è il virus Hendra, le cui epidemie, scoppiate nel 2008, sottolineano l'estrema necessità di un approccio "Una sola medicina" nella gestione delle malattie infettive emergenti. Al fine di migliorare la modalità di intervento in questo specifico ambito, l'Australia sta attuando strategie "Una sola salute" intersettoriali e intergiurisdizionali, tra cui la gestione e la condivisione più attente delle informazioni di biosicurezza, lo sviluppo inter-settoriale congiunto dell'infrastruttura di laboratorio, iniziative e approcci "Una sola salute" alla ricerca. Tali misure stanno migliorando le competenze e la capacità di intervento dell'Australia alle malattie e al contempo sostengono gli sforzi tesi a conseguire un maggiore controllo delle malattie infettive emergenti in questo paese.

Parole chiave

AusBIOSEC, Australia, Biosicurezza, Hendra, Informazioni, Malattia emergente, Salute, Salute pubblica, Ricerca, Transdisciplina, Una sola salute.

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Introduction

The recent emergence of diseases such as severe acute respiratory syndrome (SARS) and highly pathogenic avian influenza has heightened awareness of the links between disease in wild animals, livestock and humans. As human, livestock and wildlife demographics have changed, so too has the risk of the spread of disease amongst the different populations. This increased risk has led to the development of stronger connections between the human health, livestock health and wildlife sectors and the 'One Health' concept.

'One Health' seeks to improve the health and well-being of all species by enhancing cooperation and collaboration across the public health, environment and livestock sectors to combat emerging infectious disease (EID) threats. The concept of 'One Health' has been developed as a result of an increased understanding of the factors leading to the emergence of zoonoses and recognises that human and animal health are inextricably linked.

There are compelling arguments for establishing 'One Health' approaches to better address EID risks, namely:

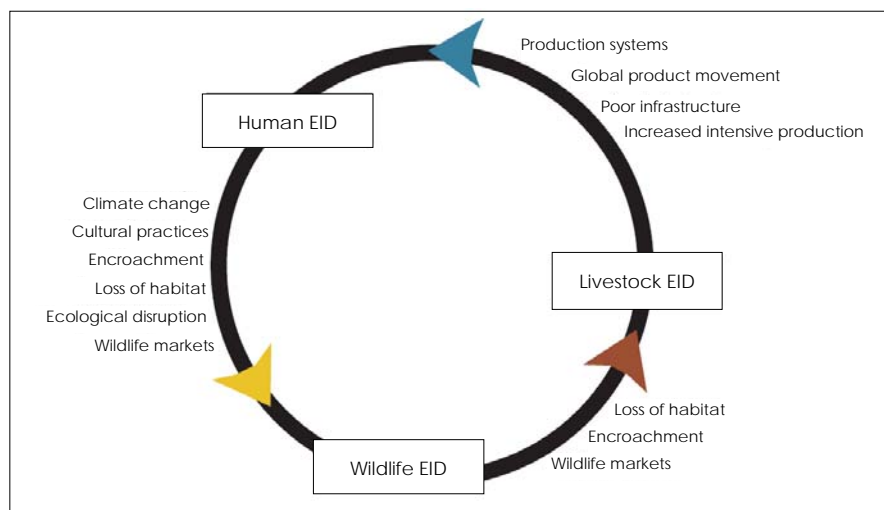
- transboundary and epidemic/epizootic prone diseases, such as avian influenza, foot and mouth disease, SARS and Nipah virus, have caused significant social disruption and

economic damage in countries and regions with severe destabilising effects. Many of these diseases include humans, and/or domestic, feral and wild animals in their ecology

- 75% of EIDs in humans over the past two decades have been zoonoses (8)
- the World Economic Forum (18) ranked human pandemics in the top four for costs (estimated at up to US\$1 trillion) and in the top three for numbers of deaths, out of 23 core global risks to the international community over the coming decade
- wildlife diseases are increasingly being recognised as a significant threat to both domestic animal and human health
- climate change has emerged as one of the defining challenges of the 21st century and we are yet to determine its impacts on disease ecology and emergence
- outbreaks associated with the deliberate or accidental iatrogenic release of infectious agents is a continuing and significant global risk.

Disease emergence

Disease emergence is the result of a complex interplay of many factors, including economic, social and scientific matters (4). Risk factors can be considered from the perspective of wildlife, livestock and human disease. Some of these factors are outlined in Figure 1.



EID emerging infectious disease

Figure 1
Factors contributing to disease emergence

The destruction and manipulation of ecosystems has enhanced the risks associated with wildlife disease. Habitat loss and movement of wildlife has altered the spread of disease from wildlife to livestock and humans as the patterns of contact change. The impact of climate change remains to be elucidated although it may be expected to have a variety of effects on agent, host and environment. As an example, the recent movement of bluetongue virus into Europe has been attributed to changing vector distribution that has, in turn, been attributed to climate change (13).

The risk of the entry and spread of infectious disease in human populations has been exacerbated by increased urban population density and global travel. Cultural and social factors, such as the slaughter and consumption of bush meat and of the sale of wildlife in wet markets, also make a significant contribution to this risk. Paradoxically, increased wealth can reduce risks associated with endemic infectious disease but may also increase the risks associated with EIDs. The effects of increased wealth on 'lifestyle' diseases, such as diabetes and heart disease, also need to be considered. Again, the impact of climate change remains to be determined.

Increasing wealth has also meant an increase in demand for animal protein. This has resulted in changing production systems with increased intensive animal production. This is often accompanied by poor or lagged development of appropriate infrastructures and quality controls to support such production systems, again increasing the risk of adverse events, including EIDs. The global movement of animals and genetic material, increased monoculture production systems, inattention to genetic diversity and the potential adverse effects of selection on non-performance traits, including disease resistance, may all contribute to increased susceptibility to disease events and the magnitude of the impact of an event.

The global market in which we live allows the rapid movement of people, livestock and livestock products around the world. The rapid transboundary movement of SARS and

H5N1 avian influenza demonstrated how easily and rapidly disease can move throughout the world. SARS was clearly spread by the movement of infected people. The contribution of legal and illegal movement of poultry, wild bird migration and inappropriate vaccine usage to the spread of avian influenza remains to be determined.

The biology of disease-causing organisms is also a critical contributing factor. Changing environments allow increased opportunities for the emergence of variant organisms. RNA viruses have high inherent variation by virtue of their replication processes and lack of proof-reading enzymes, leading to a quasi-species situation with associated difficulties in detection and control. Variant viruses can become established in different ecological niches. For example, the high levels of variation seen in influenza virus make this a difficult disease to control as variants circumvent vaccines and/or become established in wildlife reservoirs. DNA viruses tend to be more stable with less inherent variability but are still able to rapidly adapt to a changing environment. Bacteria have greater genetic complexity and potentially a greater ability to adapt to a niche. Antibiotic resistance in bacteria is a complex emerging problem that does not receive the attention it requires. Parasites are also changing. The complex parasite life cycles and immune responses make them difficult to control. As with bacteria, parasite resistance to therapeutic drugs presents significant problems, malaria being a case in point.

Emerging infectious disease in Australia

Australia has been confronted with emergent disease issues on a number of occasions over the last 15 years. Examples of diseases that have caused problems in Australia include the Hendra virus, Menangle virus, Australian bat lyssavirus, abalone herpesvirus and Japanese encephalitis virus (Table I).

In many of these disease situations, an outbreak is associated with the spill-over of disease from a wildlife reservoir to humans or

Table I
Examples of new and emerging disease outbreaks in Australia

Disease/agent (Ref.)	Date of outbreak(s)	Zoonosis	Wildlife involved
Avian influenza (5)	1976-1997	Yes	Possibly wild waterfowl
Dengue (9)	1981-2008	No	No
Hendra virus (6)	1994-2008	Yes	Bats (<i>Pteropus</i> spp.)
Pilchard herpesvirus (17)	1995	No	Pilchards (<i>Sardinops sagax neopilchardus</i>), probably no vector
Australian bat lyssavirus (15)	1995	Yes	Bats
Japanese encephalitis (7)	1995	Yes	Possibly domestic and feral pigs
Menangle virus (12)	1997	Yes	Bats
Chytrid fungus (2)	1998	No	Amphibians
Tasmanian devil facial tumour (11)	2002	No	Tasmanian devil (<i>Sarcophilus harrisi</i>), probably no vector
Porcine myocarditis (10)	2003	No	No
Leishmania (14)	2004	No	Macropods
Abalone herpesvirus (16)	2005	No	Wild abalone (<i>Haliotis</i> spp.)
Equine influenza (3)	2007	No	No

livestock. One of the best examples in Australia of an EID that involves wildlife, livestock and humans that is truly dynamic is the Hendra virus.

In September 1994, a prominent Queensland horse trainer and his stable hand, along with most of the horses in his stable fell ill. Within several days, the trainer and 14 horses were dead. Hendra virus was subsequently isolated from specimens obtained during this outbreak of respiratory and neurological disease in horses and humans in Hendra, a suburb of Brisbane, Queensland. To date, the virus has only been found in Australia although a closely related virus (the Nipah virus) is found in South-East Asia and is causing disease in Bangladesh and India. Originally called equine morbillivirus, it was subsequently reclassified and named Hendra virus, a member of a new genus, Henipavirus, of the family Paramyxoviridae. The Henipavirus genus now contains two virus species, the Hendra virus and the Nipah virus. Unlike other Paramyxoviridae viruses which tend to be host-specific, Hendra virus can infect more than one animal species. Research has shown that horses, cats and guinea-pigs can be infected experimentally and excrete virus in their urine.

Fourteen horses died as a direct result of Hendra virus infection, while another seven horses shown to be infected were humanely destroyed during the original outbreak in September 1994. Two people who had close contact with the first horse to become ill were also infected with the virus, and one of those people died.

A third person from Mackay, central Queensland, was diagnosed with Hendra virus infection in October 1995. Two horses had died on his property during August 1994; at the time, the horse deaths had been attributed to avocado poisoning and snakebite. The man had become ill at about the same time as his horses and had close contact with the horses before and after their deaths. Retrospective testing for the Hendra virus on preserved tissues from these horses found that both horses had been infected with the Hendra virus. The horses in Mackay died about four weeks before the first Brisbane horse became ill, however the cases are geographically distant and to date no link has been found between the two outbreaks.

A third Hendra virus disease occurrence was recorded in January 1999, when a thoroughbred mare used for polocrosse became ill with facial swellings and died

suddenly. Tests confirmed Hendra virus infection in tissue samples from this horse.

Since 1999 there have been several more cases (approximately one per year), including one case in New South Wales in 2007. These are outlined in Table II.

At the time of writing (February 2009), the most recent outbreak of great concern occurred in July 2008 in horses infected at a veterinary clinic in Redlands, Brisbane, and in a separate outbreak in Northern Queensland. At the Brisbane clinic, two members of staff were also infected, one of whom died. In the Brisbane outbreak, three horses died and the others were destroyed. The outbreak in Redlands appears to be associated with somewhat different clinical signs and a variant virus. The precise analysis of this remains to be undertaken.

Following extensive study, all four species of flying foxes (also called fruit bats) (*Pteropus* spp.) in Australia were shown to be reservoir hosts of the Hendra virus (i.e. they carry the virus but do not show symptoms of disease). Flying foxes are dispersed widely throughout Australia and overseas. The relatively high sero-prevalence seen in trapped and tested bats suggest that many, if not most, bats in a colony have been exposed to the virus at some time in their lives. This is contrasted by the low level of virus identification and isolation from these trapped bats. It is possible that the virus

is cycling in bat colonies at relatively low levels. The level of virus, or the proportion of bats shedding virus in colonies, most likely increases due to factors that are as yet unknown, including for example, temporal, spatial or physiological factors.

Evidence of infection has been found in bat colonies from Darwin across to the east coast and south to Melbourne. As only 11 outbreaks of Hendra virus infection have been recorded since 1994, it appears that spill-over of this virus from a natural host to other species is a rare event. Whether fruit bats are the only wildlife reservoir is still unknown.

Infection in horses appears to be associated with transfer of virus from infected bats. It has been postulated that urine or faeces from infected bats contaminates horse feed or water, resulting in the subsequent infection of horses.

However, horses are not the only susceptible animal and there may be another wildlife or domestic animal host. It is known that rodents can be experimentally infected and shed virus.

Hendra virus does not appear to be highly contagious to other animals and humans, but if infection does occur it can be fatal. Despite evidence that approximately 25% of flying foxes have been infected with Hendra virus, it appears that direct contact between flying foxes and people is not a significant risk for human infection with the Hendra virus. However, this may relate to the low chance of

Table II
A summary of Hendra virus infection in Australia, August 1994-February 2009

Year (month)	Location	Equine cases	Human cases	Human deaths
1994 (August)	Mackay (Queensland)	2	1	1
1994 (September)	Hendra (Queensland)	20	2	1
1999 (January)	Trinity Beach (Queensland)	1	0	0
2004 (October)	Gordonvale (Queensland)	1	1	0
2004 (December)	Townsville (Queensland)	1	0	0
2006 (June)	Peachester (Queensland)	1	0	0
2006 (October)	Murwillumbah (New South Wales)	1	0	0
2007 (June)	Peachester (Queensland)	1	0	0
2007 (July)	Clifton Beach (Queensland)	1	0	0
2008 (July)	Redlands (Queensland)	5	2	1
2008 (July)	Proserpine (Queensland)	3	0	0
Total		37	6	3

contact between a human and a bat that is shedding virus. All people who have been infected with Hendra virus appear to have contracted it from acutely ill horses.

Horses show signs of clinical disease following infection. People who care for sick horses or undertake post-mortem examinations on infected dead horses are at significant risk of infection. It then appears that the virus is spread from horse to horse mainly through inadvertent mechanical transmission, perhaps associated with human interventions applied in the care of sick horses.

Hendra virus appears to be a classic example of a virus that has evolved with its naturally occurring wildlife host. There appears to be little, if any, clinical disease in bats which from time to time shed sufficient virus to cause infections in non-natural hosts. The disease in the non-natural host (horse) can then spread to a second non-natural host (humans) with severe and potentially fatal consequences.

'One Health' challenges

Hendra virus infection that involves bats, horses and humans presents a challenge to disease outbreak forecasting and management. Surveillance and identification of risk factors is difficult due to the unusual wildlife host. The response to an outbreak involves close cooperation between wildlife biologists, livestock disease managers and human infectious disease specialists.

Forecasting outbreaks and spill-over events remains an ideal that is unlikely to be easily attained. Improved intelligence gathering and preparedness may result in better management and mitigation of the risks associated with an outbreak event. However, the prediction of a specific spill-over event, such as SARS, is unlikely to ever be achieved. The longer term objective of such forecasting should be to identify generic risk factors and the processes for the improved mitigation of those factors through enhanced preparedness and contingency planning.

Wildlife disease has generally not been considered important until a spill-over event occurs that has an economic or public health

impact, or a national icon is threatened e.g. Tasmanian devil (*Sarcophilus harrisi*) facial tumour disease. This is a considerable challenge to a 'One Health' approach. The wildlife/conservation sector is somewhat chaotic with very diverse interests involved. Support for wildlife disease monitoring and outbreak investigation is limited and has a low priority. In Australia, there is no one organisation with responsibility. Identification of leishmania in red kangaroos (*Macropus rufus*) took a number of years. Support for chytrid fungus work has been limited, to say the least, and this is an excellent example of a very high impact condition that has taken years of devoted commitment to describe and understand and, even now, still appears to be poorly funded. Given the current situation in Australia, climate change and water resources have a higher priority in the environmental sector than wildlife diseases meaning that the wildlife sector is likely to continue to be chronically underfunded with little recognition by decision-makers and the community of the relationships between wildlife disease and other sectors, such as livestock and human health. The processes required to collect and validate wildlife disease data and the requirement for contextual data, such as population-at-risk information, to facilitate meaningful interpretation, presents a huge challenge. There is a considerable amount of information available but much of it is in a form that livestock and human infectious disease specialists would consider as unusable or of little value. Anecdotal information can often be collected from a variety of sources, such as ornithologists, wildlife carers, hunters and ecotourist operators. There are major additional demands associated with integration of data from disparate sources, validation, analysis and interpretation before it can be considered as 'usable' information.

An outbreak of disease in wildlife is difficult to detect, contain, track and monitor. There is no coordinated response capability with a clear wildlife focus, no line of responsibility and no process for the allocation of costs. Arguably, this lack of preparedness in the wildlife sector leaves us vulnerable. On the other hand, it is

hard to know where to focus resources in such a vast sector with many disparate and unconnected parties. A structured risk-based approach may help priority setting.

Livestock disease is a major threat to trade and livestock industries generally recognise the nature of the threats and are more proactive in addressing threats from EID. The Australian agriculture sector makes an important contribution to the national economy and is relatively well prepared to respond to outbreaks of livestock disease. There is a high level of experience in outbreak management at state and national levels following responses to avian influenza, Newcastle disease and equine influenza. In such outbreaks, an observer from the public health sector is involved. The sharing of costs associated with managing an outbreak of a disease which is exotic to Australia is pre-determined through an agreement between government and industry.

In the public health sector, the imperatives are somewhat different in that chronic lifestyle diseases have a much greater impact but attract less public and political attention since new diseases that affect humans elicit a more emotional response. However, the threat of the unknown is real. From an international perspective, SARS could easily have spread much more widely had the response been less well coordinated. Outbreak response in Australia has the potential to be well coordinated through the Commonwealth Department of Health and Ageing. However, we have yet to face a large outbreak of an EID in humans in Australia. A considerable amount of activity has been undertaken in planning and preparation for an influenza pandemic. While some of this activity is disease-specific, much is devoted to improving our generic disease response capability. The planning processes and exercises that have been undertaken in response to bird flu have involved joint cooperation between the public health and livestock sectors.

Even within the more structured and resourced livestock and public health sectors, the collection and sharing of disease intelligence still remains complex. With reduced government resources directed to

active disease surveillance, we need to develop a broader base for the collection of information and to realise value from various sources of disease data, including leveraging more value from existing passive systems for example, and developing innovative methods of collecting and using additional data. An added complexity is the storing of information across multiple jurisdictions and sectors. Within each sector, disease information is collected at multiple levels including private organisations, universities, research institutions and government departments.

The major challenge we face is to collect, synthesise and communicate information that assists in the identification and mitigation of the risks associated with disease emergence. This needs to be done in the absence of an outbreak situation.

There are also additional 'One Health' challenges faced in an outbreak situation. In a disease outbreak that involves wildlife, livestock and human disease, a co-ordinated cross-sector response is critical. Appropriate sample collection and sharing is essential. Not all laboratories will have validated tests for organisms of interest. A process for sharing the outcomes of test information is required. The response to a disease such as Hendra virus must take into account factors from the three sectors involved. Hence decision-making needs to be based on a 'One Health' approach.

In achieving this 'One Health' approach, an understanding of the social, behavioural and political elements are crucial. Wildlife biologists will be concerned over the impact of the disease and the repercussions on wildlife. In the case of Hendra virus, it is recognised that bats are an important component of the ecosystem. Scientists' adrenalin flows with the thought of a new disease and a new virus. Disease managers need to get the disease under control and minimise adverse economic and public health implications. Disease managers in government agencies can also be placed under immense political pressure.

In both risk management and in an outbreak situation, communication is critical. It is easy for the public to get the risks out of proportion,

so clear and simple messages are required. In the case of Hendra virus, risks to humans and horses can be reduced by appropriate behaviours in minimising contact between bats and horses and implementing appropriate biosecurity measures in handling sick horses. Such messages need to be delivered by people who have authority and are likely to be trusted by the public and the specific community involved. It is easy for the community to take the risk of infectious disease out of proportion to other risks in our every day lives.

‘One Health’ response

The ‘One Health’ concept is gaining currency in Australia but requires considerable further development to better manage and mitigate the risk from EIDs.

Each sector involved in EID management has shared imperatives and response capacity as well as some unique elements.

Across the three sectors, there is a need for improved joint information collection, management and analysis. In addition to working across sectors, there is a need to improve the manner in which information is gathered across the various jurisdictions and agencies involved in EID response and management.

Improved access to information and improved information sharing has been identified as a critical issue in outbreak simulation exercises. This approach will improve forecasting, risk analysis, risk management and risk mitigation. Ultimately, this will reduce risks, improve outbreak response and management and reduce the impact.

The optimal manner to achieve cross-sector and cross-jurisdictional information sharing is far from clear. As well as a lack of infrastructure, operational and behavioural changes are required. A different information paradigm in the biosecurity sector is required. This is outlined below in Figure 2.

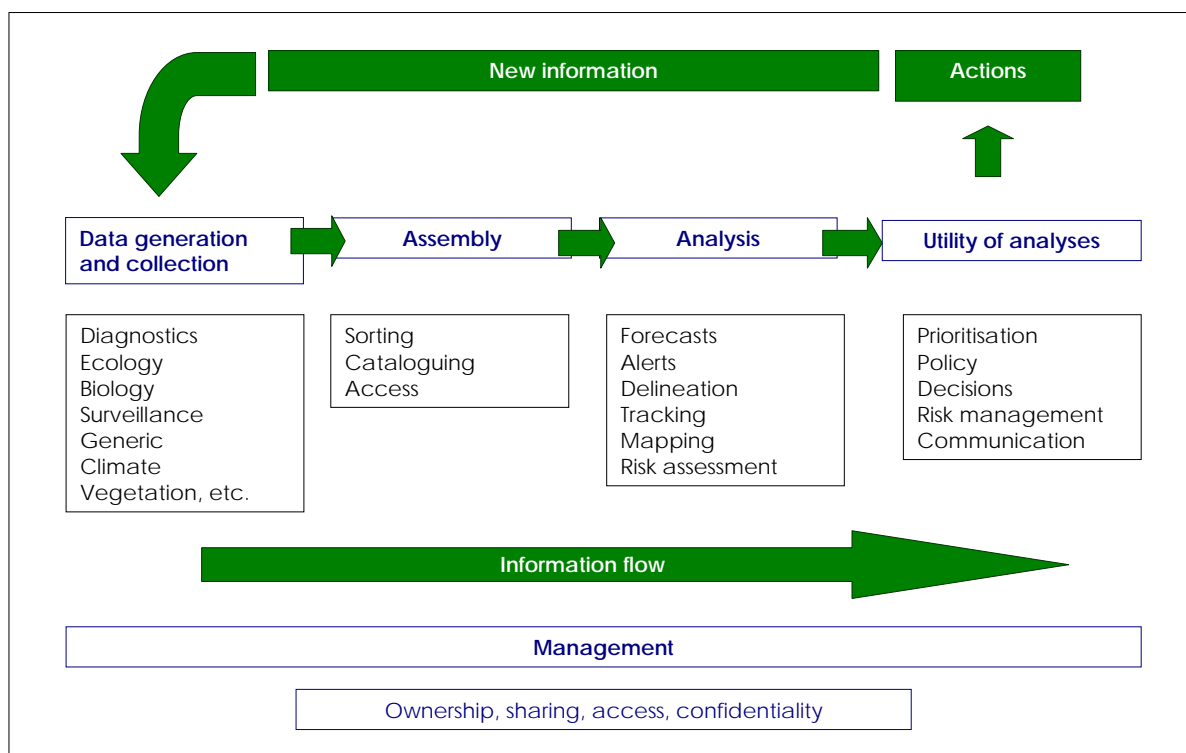


Figure 2
 A biosecurity information paradigm
 Data can be collected across sectors and more effectively used in forecasting and risk management
 A ‘One Health’ response gives rise to further information
 Cross-sectoral information management issues must be addressed

Despite the challenges, considerable progress is being made in Australia through infrastructure initiatives, policy approaches and research initiatives.

Improving biosecurity information infrastructure

Technological developments in most disciplines involved in biosecurity have resulted in the generation of large amounts of data and information. A significant challenge faced by all sectors is to get the right information to the right people in a timely manner to allow them to make the best evidence-based decisions. A number of areas have been identified for improvement in national biosecurity information infrastructure, including enhanced connectivity, data access and linkages, data analysis and near real-time information sharing. These developments will need to be made in the face of anticipated reductions in operational resources and will need to be scalable or able to manage vast increases in data and information inputs. A number of biosecurity exercises undertaken at state and national levels have provided this message and the Australian Biosecurity Intelligence Network (ABIN) has recently been established with Australian Government funding.

The purpose of ABIN is to develop biosecurity information management infrastructure, including a shared workspace that allows individuals and groups to collaborate across sectors and jurisdictions, sharing information and tools. The key outcome of ABIN will be a national biosecurity collaborative platform that enhances biosecurity research, surveillance and response capability.

A core ABIN capability is proposed with a focus on biosecurity infrastructure that enhances connectivity, information management, access and analysis. There are seven projects that utilise and build on that core capability. These projects are designed to demonstrate how ABIN can deliver value to stakeholders in the sector as well as to engage researchers in ABIN activities. The projects cover agriculture, public health and wildlife

sectors and include emerging influenza, fruit fly (*Drosophila melanogaster*), veterinary pathology, salmonella, arboviruses, aquatic animal health and multi-drug resistant tuberculosis. In addition, there are activities in wildlife biosecurity and in laboratory information management.

Co-location of livestock and public health facilities

State governments in Australia are moving to consolidate biosecurity activities under common structures and frameworks. Possibly the best developed of these consolidations is located in Queensland with similar activities also underway in Western Australia and Victoria. Queensland has combined biosecurity activities across plants, insects, animals and aquaculture into one family through the establishment of 'Biosecurity QLD'. However, the difficulties in developing effective and functional linkages between animals, wildlife, the environment and human health remain.

The Queensland government is also developing a Health and Food Sciences Precinct (H&FSP) in Brisbane which will bring together animal health and production scientists, public health scientists and food scientists to create a vibrant knowledge centre for health and food. This Precinct, comprising about 700 scientists and support staff, will be a centre of excellence focusing on improving quality of life through advances in healthcare, medicine, food security, biosecurity and nutrition. The key design driver is the integration of existing human health sciences with animal and food sciences to develop a 'One Health' approach to health and disease research.

Co-locating complementary animal, food and human science will exploit opportunities for collaborative and whole of life cycle (environment, food, animal, plant and human health) research, capitalise on sharing resources, scientific equipment, new and emerging generic and specific technologies and maximise diagnostic capacities in human-animal disease surge situations.

A policy approach

A policy initiative aimed at achieving a common approach to improved biosecurity has been developed by the Australian Commonwealth Government together with the State governments. AusBIOSEC (Australian Biosecurity System for Primary Production and the Environment) is a framework of common principles and guidelines to enable biosecurity arrangements to be applied consistently across Australia. At this time, the public health sector is conspicuous in its absence from the process.

The aim is to connect all biosecurity activities being undertaken by the Australian Commonwealth government, state and territory governments, industry, landholders and other key stakeholders in primary production and the environment.

The scope of this work encompasses the entire biosecurity continuum and includes managing pests and diseases of terrestrial, freshwater and marine environments that could be harmful to primary industries, the natural and built environments and public health. It also covers everything from prevention and preparedness, emergency response, to ongoing management of established species.

Expected outcomes of the AusBIOSEC process include the following:

- a collective and cross-sectoral approach to biosecurity delivery across primary production and the environment
- improved management of pests and diseases that have a negative impact on the environment, livestock or public health
- a more timely and efficient response to EIDs and disease incursions
- agreed principles to provide nationally consistent policy direction
- greater clarity of roles and responsibilities for managing biosecurity matters
- cost-effective solutions to biosecurity risks
- clear linkages within and between government agencies and jurisdictions
- opportunities to identify and address gaps, commonalities and potential efficiencies in biosecurity delivery

- enhanced capacity to reduce the establishment, spread and impact of invasive organisms.

'One Health' collaborative research ventures

The Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease (AB-CRC) was established to improve Australia's capability and capacity to respond to EID outbreaks. The primary focus has been on zoonotic and exotic diseases. The AB-CRC, which is in its sixth year of a seven-year term has delivered significant benefits to the livestock and public health sectors that have been valued at AUD220 million (1). Plans are in place to continue with a second Biosecurity Cooperative Research Centre (Biosecurity CRC Mark II). This centre will be a catalyst for strengthened partnerships in research and education in Australia and the region. Its sharp focus on national and regional coordination and integration, meeting 'end user' needs, and delivering tangible outcomes, will realise mutual benefits for EID preparedness and response. Specifically the CRC will develop more effective tools for prioritising EID risks, identifying gaps, and improving measures for preventing disease establishment and spread. It will invest in targeted skills and network development, and in ensuring the research can be implemented. The CRC will boost the capacity of governments and industries to prioritise and manage biosecurity risks to protect and promote public health, the livestock industries, environment and the economy.

A Biosecurity CRC Mark II proposal currently under development will continue to build the 'One Health' approach to EIDs in Australia and the region. This will be achieved by bringing together the public health, agriculture, and environment sectors and a range of disciplines, in an integrated partnership to address the risks, responses to, and high consequence of EIDs. This partnership extends across the public health, livestock, environment and security sectors,

across national borders and scientific disciplines.

The new research centre will deliver the following outcomes:

- EID risks to Australia and the region identified, analysed and prioritised
- gaps in knowledge and capability and associated priority actions identified
- cost-effective tools and systems for managing risks developed
- intelligence, advice, tools and technologies provided to industry and governments in Australia and the region
- researchers and professionals with enhanced knowledge and skills for managing risks
- cross-sector leverage of complementary skills and expertise to optimise national capacity
- enhanced capability to respond to EID threats.

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Conclusions

Along with many other countries, Australia faces significant threats from EIDs that emanate from wildlife or involve a wildlife vector. A salient example of such a disease is Hendra virus. The outbreaks of Hendra virus in 2008 highlight the critical need for a 'One Health' approach to the management of EIDs. In Australia, cross-sectoral and cross jurisdictional 'One Health' approaches to the improved management of EIDs are being undertaken. These include improved management and sharing of biosecurity information, the joint cross-sectoral development of laboratory infrastructure, 'One Health' policy initiatives and 'One Health' approaches to disease research.

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