

# CHAPTER TWO: LOW BURDEN..... HIGH THREAT

The burden of illness and death from most communicable diseases is much lower in Australia than in the developing countries of our neighbourhood<sup>40 41 42</sup>. Nevertheless, while our burden of illness from communicable disease is currently low, many diseases still pose potential threats. Indeed, experts understand that serious outcomes have been averted in Australia because of our well-established pathways for prevention and our public health systems for control of communicable disease. This chapter will help Australians to understand this low-burden, high-threat situation. While most Australians can take our low disease burden for granted, as a nation we must thank our vigilant health workforce, working behind the scenes to keep current or new diseases under control.

## THREATS THAT HAVE LONG BEEN WITH US

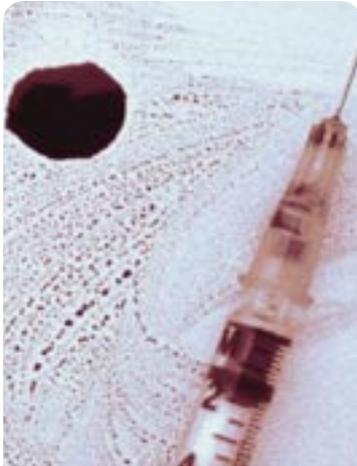
### INFLUENZA

Influenza is a viral illness spread from person to person through coughing, sneezing and through contact with infected droplets. It is a significant cause of illness and death, even though the impact of seasonal influenza can be significantly reduced by annual immunisation. In an average year, up to 30,000 Australians are hospitalised and around 2,000 may die as a direct or indirect consequence of influenza. Influenza viruses are constantly evolving. A vaccine that works in one year may be ineffective in the next. If the dominant strain that emerges in the next influenza season is very different from the previous year's, there will be little protection from pre-existing immunity<sup>43</sup>. Indeed, a strain of influenza that is completely novel could cause a world-wide epidemic (pandemic) and severe illness<sup>44</sup>.

How does such a new strain of influenza emerge? Our immune responses against influenza are directed at two proteins that are on the surface of the virus. Antibodies against these proteins protect us from illness. The proteins are haemagglutinin (H) and neuraminidase (N). Mutations in the H and N genes ('antigenic drift') allow influenza variants to emerge that are not susceptible to antibodies against the earlier strain. Such mutant strains have a selective advantage in spreading within a population immune to last year's virus. This explains how influenza can recur every winter. The composition of the 'flu vaccine is changed each year to anticipate the influenza types that are most likely to become dominant in the next winter.



Frank Macfarlane Burnet (L) whose earlier influenza research paved the way for the discovery of the neuraminidase inhibitor by Peter Colman (R) and his team. The molecular model of neuraminidase is at centre stage.



The greater the change in H and N proteins, the less likely it is that the virus will be recognised by pre-existing immunity and the greater the epidemic potential. At irregular intervals, there are dramatic changes in the viral proteins, known as 'antigenic shifts' which can result from an exchange of genes (reassortment) between viruses of humans and those of birds and pigs. Following such a major antigenic shift, the novel virus can cause a pandemic by spreading into a population that has little immunity to the changed H and or N antigens. Mutations in other influenza genes also contribute to viral virulence and to mortality in a pandemic.

### Box 2.1 Influenza and Immunity

- *H and N genes (RNA) encode H and N proteins which contribute to viral infectivity.*
- *H & N are recognised as antigens by our immune system.*
- *We maintain cells and antibodies against previously encountered influenza strains as immune memory.*
- *Influenza strains with changed H and or N genes (and thus different antigens) are not recognised by cells and antibodies that protected us against earlier strains.*
- *A mutant or recombinant influenza strain then has a selective advantage and can spread widely to become the new dominant strain in a population that is immune to an earlier strain.*

There were three influenza pandemics in the 20<sup>th</sup> century. The devastating Spanish Influenza of 1918-1919 caused at least 20 million deaths worldwide. Australian troops in France during the First World War were also severely affected by influenza in October 1918<sup>45</sup>. The Australian Director of Quarantine decided to exclude the disease by quarantining 174 'infected vessels'. Although influenza broke out in some ships detained in quarantine, there was no escape of infection to the shore population. When

influenza did occur in Melbourne in January 1919, it was milder than the disease experienced elsewhere in the world,<sup>18</sup> possibly because, over time, patients with severe symptoms were more effectively isolated. Eventually there were some 12,000 Australian deaths from influenza in a population of five million. Over half of the fatalities were in young adults. This mortality, over a short period, was proportionally much greater than that from HIV/AIDS over almost twenty years in Australia.

### Box 2.2 Influenza A Pandemics

*1918-1919 Spanish Influenza A (H1N1)*

*1957 Asian Influenza A (H2N2)*

*1968-69 Hong Kong Influenza (H3N2)*

There was a lucky escape in 1997 when a new influenza A (H5N1) strain in Hong Kong, able to spread from chickens to people and cause fatal disease, was found to be unable to spread from person to person.



The Spanish Influenza travelled around the world in less than 12 months; Hong Kong (1968-1969) influenza took only six months to navigate the globe and it reached Australia within two months. A future pandemic is likely to spread even more quickly because of the speed and frequency of human travel.

In such an emergency, we will have to depend on rapid vaccine development and new antiviral drugs. Fortunately, Australia has been a world leader in influenza control. Indeed, Australian research paved the way for production of influenza vaccines and antiviral drugs. It was Sir Frank Macfarlane Burnet's method for cultivating influenza viruses in eggs, published in 1941, that remains the basis for vaccine production. Specific anti-influenza medicines binding to the N (neuraminidase) protein have also been developed. One of these, zanamivir (Relenza<sup>®</sup>) was invented in Australia. These new drugs, if administered before exposure, are able to prevent infection.

If administered soon after first symptoms appear they reduce the severity of disease and virus shedding.

While we cannot predict the timing or severity of the next influenza pandemic, it is unlikely that the world will be spared indefinitely. Pandemics have occurred about three times each century over the last three centuries. The World Health Organization (WHO) formulated an Influenza Pandemic Preparedness Plan in 1997<sup>46</sup> to define its role and make recommendations for member nations. Through its four influenza collaborating centres, one of which is in Melbourne, WHO will continue to provide reliable information, detect and identify viruses with pandemic potential, evaluate levels of risk and collect and distribute virus strains suitable for vaccine production. Australian preparedness<sup>46</sup>, oversights by a National Influenza Pandemic Action Committee chaired by the Chief Medical Officer, will ensure national surveillance and action to minimise illness and death in any future pandemic.

## TUBERCULOSIS

Tuberculosis (TB) is a highly contagious bacterial disease which most often affects the lungs. It still kills 2 – 3 million people worldwide each year. When an infected person coughs or sneezes, TB bacteria in small-particle droplets can dry to

give infective particles that remain suspended in the air for long periods, to be breathed in by others. People in casual contact are usually at low risk of becoming infected, whereas continuous, close contact in the same household brings higher risk, particularly in overcrowded circumstances. Sunlight kills infective particles within a few minutes.

### Box 2.3 'Tuberculous' Opera

*An opera singer with a tuberculous lesion on a vocal cord spread the disease to many in his audience when he sang.*

Tuberculosis is curable with appropriate treatment. Standard therapy requires at least six months of treatment with different combinations of drugs; this means that adherence to treatment can be a problem. Those who do not adhere to prescribed treatment risk a relapse and continue to be a source of infection for others. For these reasons, WHO recommends 'Directly Observed Treatment, Short Course' (DOTS), whereby a health worker watches each patient swallow medications<sup>47</sup>.

Infection with a resistant TB bacteria makes treatment expensive and reduces the success rate. Drug resistant tuberculosis, common in south-east Asia, could become established in Australia if a resistant strain were to spread from an imported case. As with all treatable infections, incomplete treatment also gives a selective advantage to drug-resistant strains (see Box 1.10).

The incidence of tuberculosis in Australia is low by world standards at around 6 new cases per 100,000 population each year. This is a legacy of government commitment to tuberculosis control from the 1950s to the 1970s. So why is tuberculosis still a threat? First, some Australians are still at high risk: recent immigrants, Aboriginal people and Torres Strait Islanders, health care workers, older people, those who are alcohol dependent, in prisons or other institutions, or those living in overcrowded conditions. Second, Australia is at risk of the importation of antibiotic-resistant TB from overseas. Third, persons with immune systems damaged by HIV, cancer, or medications are particularly susceptible<sup>48</sup>.

## MALARIA AND OTHER VECTOR-BORNE DISEASES

When bitten by a mosquito, most of us think of irritation and itching, but some of us turn our thoughts to diseases that the insect (vector) may be carrying. Vector-borne infections result as organisms are transmitted by bites of insects such as certain mosquitoes and ticks. The vector picks up the organisms from the blood of infected people or animals and carries them to the next victim it bites. Although the pathogen typically replicates in the vector, the vector usually suffers no ill effects itself.

### Box 2.4 Exotic Mosquitoes

*In 2000, the Australian Quarantine and Inspection Service (AQIS) reported 41 interceptions of mosquitoes on goods (such as car tyres) inspected at our borders. Amongst these, 22 species of mosquitoes were new to Australia or found only in limited areas of Australia.*

Numerous exotic viruses have spread around the world through migration of birds, through importation of infected mosquitoes, or through travel of infected people<sup>9 12 16</sup>. Disease can spread to humans via mosquitoes that have fed on the blood of an infected bird. For

example, the West Nile virus globe-hopped from the Middle East to North America in 1999. The first warnings of the disease, new to New York City, were six patients with unexplained brain infections (encephalitis) at the same time as large numbers of birds were dying in the city<sup>49</sup>. This outbreak exemplifies the risk of an exotic infection spreading to a developed country.

### Box 2.5 A Public Health Warning – Malaria Transmission in Australia!

*Late in 2002 a person who had previously travelled to Africa enjoyed camping at one of Australia's most beautiful spots, Cape Tribulation in Far North Queensland. Unfortunately the camper was carrying infective malaria parasites in his blood. Mosquitoes that fed on his blood passed malaria to nine others in the Cape Tribulation outbreak. The disease did not spread further because of the vigilance of the Queensland health department. Mosquitoes around the camping area were suppressed through local spraying. For every one of the other nine cases, mosquito traps were set near their homes. When mosquitoes able to transmit malaria were detected, mosquito eradication was performed to remove the threat of further transmission of malaria.*

Malaria, a debilitating and life-threatening illness, is the most important global disease spread by mosquitos. Malaria parasites, called plasmodia, are endemic in many tropical countries. Malaria was previously endemic in northern Australia but was effectively eliminated in the 1960s. Subsequently it was seen in Australia only in travellers infected overseas. However, malaria transmissions at a popular camping area in Far North Queensland in 2002 show that Australia is still at risk of malaria becoming re-established. The outbreak was controlled by rapid diagnosis and treatment and by measures to control mosquitoes around the camp and the homes of cases. This episode reminds us that mosquitoes able to spread malaria are plentiful in Australia's tropical north. With any re-introduction of malaria there is a risk of re-establishing a pool of infected mosquitoes and infected people and thus re-establishing malaria as an endemic disease in Australia.



Mosquito image courtesy of Department of Medical Entomology, ICPMR, Westmead Hospital, NSW. [www.medent.usyd.edu.au](http://www.medent.usyd.edu.au)

Mosquitoes can also transmit viruses. Most common in Australia<sup>50</sup> is Ross River Virus, which causes fever, joint pains and rash in some 4,000-6,000 cases diagnosed each year. The virus is most often spread to people by mosquitoes that have previously bitten marsupials or birds that harbour it. Another rare but potentially deadly virus transmitted by mosquitoes is Murray Valley Encephalitis.

We also worry about viruses such as dengue, a severe and sometimes life-threatening viral disease with no specific treatment. Dengue virus has been introduced on numerous occasions, usually by travellers returning from endemic areas in south-east Asia and the Pacific Islands. A mosquito species capable of transmitting the virus (*Aedes aegypti*) has re-emerged in far north Queensland. Early in 2003 an outbreak of dengue in this area affected hundreds of people and led to a temporary ban on transfusion of blood that had been locally collected. As with malaria, dengue could become a permanent Australian disease if we relax our vigilance and if outbreaks are not controlled by measures to reduce mosquito numbers and biting rates<sup>51</sup>.

Japanese encephalitis virus (JEV) is also spread by mosquitoes and causes serious infection with high death rates in overseas outbreaks. Fortunately JEV disease can be prevented by vaccination of people at highest risk, although the presently available vaccines still need to be improved. When the virus was introduced to Badu Island in Torres Strait from Papua New Guinea in 1995, presumably by infected birds, there was a disease outbreak in humans. The virus was spread by the mosquito vector (*Culex annulirostris*) to domestic pigs and then to three people. Another case on the island occurred in 1998 but this time the virus also spread to the Cape York mainland, where another person was infected. This incursion is worrying, as suitable vectors and animal hosts could establish JEV permanently<sup>52</sup> and threaten more populous areas of the country. At present, it is not feasible to vaccinate all potential animal and human hosts against the virus.

In the longer term, with global warming, northern Australia could become both hotter and wetter, providing more favourable conditions for vector mosquitoes and expanding their range into southern areas.

## SEXUALLY TRANSMITTED INFECTIONS (STIs)

Sexually transmitted infections are still important as public health problems in Australia. They can cause severe disease in their own right, but also favour the transmission of HIV infection<sup>53 54</sup>.

In Australia today, the most common STI is caused by human papilloma-virus (HPV). Some HPV subtypes cause genital warts, while other subtypes cause few acute symptoms, but can lead to cancer of the cervix or anogenital tract in the longer term. Recently, Australian research has led to the development of a vaccine that appears to be highly effective in preventing HPV transmission.

The second most common STI is genital herpes, caused by a virus (HSV2) that often becomes latent but tends to break out from time-to-time with recurrent genital sores. Although there is no vaccine, recent advances in antiviral treatment have made these episodes much more manageable. Herpes during pregnancy can pose a serious risk to the foetus, particularly with primary infections.

Other STIs are bacterial in origin and can usually be fully cured by antibiotics. In past generations, syphilis was widely feared, because it could not be treated. After World

War 1, there was a small cohort of Australians with chronic syphilis affecting the brain and spinal cord or blood vessels. After World War 2 however, the risks were greatly reduced because of penicillin treatment. Today, syphilis lingers on only in those with restricted access to health care. If a mother is affected by syphilis during pregnancy, the infant can suffer severe congenital anomalies. There is thus a need for continuing awareness and for appropriate screening of groups who may be at risk.

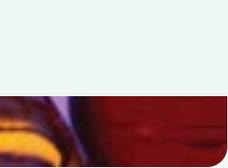
Gonorrhoea, with inflammation and discharge from the urethra or vagina, tends to be less painful in women and is thus more likely to go untreated than in men. Untreated infections can damage the female reproductive tract, leading to pelvic pain and even to infertility, or to uncommon but life-threatening complications such as ectopic pregnancy. Until recent years, gonorrhoea could be cured with

penicillin. Today, many gonococcal strains are resistant to penicillin and other antibiotics and effective treatment may require the use of 'third generation' antibiotics.

There is also major concern about sexually transmitted chlamydial infection, which can also go unnoticed and lead to chronic pelvic inflammatory disease and infertility. The seemingly inexorable rise in chlamydia notifications in recent years (See Figure 2.1) may be partly due to the introduction of more sensitive methods for laboratory diagnosis and to improved surveillance. However, now that these tools for better detection are available, the challenge is to ensure that all affected people receive prompt and adequate treatment. In the medium term this should be followed by a decrease in notifications and in the longer term, by a decrease in infertility and the other complications of chlamydial infection.

Figure 2.1 Notifications of cases of chlamydia infection 1995 - 2002  
National Notifiable Diseases Surveillance





Donovanosis, which causes ulceration and disfigurement of the genitals, is seen rarely and then only in remote locations with limited access to health care. Following recent improvements in diagnosis, surveillance and treatment, donovanosis should soon be eliminated.

In the early 1980s, when HIV first appeared, we saw a sharp decline in numbers of some types of STI as many people changed their sexual behaviour to protect themselves from this new fatal disease. More recently, there has been a resurgence of STIs, perhaps because people see HIV as less of a threat now that treatment is widely available. Safe sex messages for the prevention of all STIs are summarised in Chapter 3.

## THREATS THAT HAVE BEEN MORE RECENTLY RECOGNISED

### HUMAN IMMUNODEFICIENCY VIRUS (HIV) AND AIDS

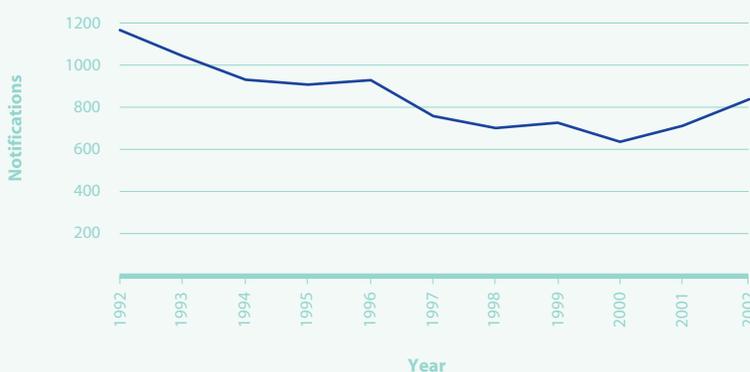
The human immunodeficiency virus (HIV) is predominantly a sexually transmitted infection, but it can also be transmitted by blood contact<sup>8 9 53 55</sup>. In the early stages, persons with HIV infection are usually symptom-free. However, when untreated, HIV attacks a part of the immune system (T-lymphocytes) and leads to AIDS (acquired immune deficiency syndrome) after a median period of ten years following infection. HIV/AIDS has affected all countries and is devastating parts of Africa and Asia. Over 30 million have been infected world-wide. Countries with limited resources for education and treatment and with large numbers of men working away from their families have been most affected.

In Australia, transmission of HIV peaked in 1984, with about 2500 new infections per year<sup>56</sup>. Subsequently, new HIV infections declined in Australia (see Figure 2.2), following public awareness of the risks, successful education campaigns and surveillance and treatment programs. By 2003, HIV had infected some 20,000 Australians (1 in 1000 of the population). HIV has mainly

#### Box 2.6 Transmission of HIV

- Most HIV transmission in Australia has been through men having sex with men, whereas globally, most transmission is heterosexual.
- Some blood-borne HIV infections are transmitted by injecting drug use. Needle and syringe distribution on a wide scale has helped to reduce the risk for people injecting illicit drugs.
- Australia recognised the risk from blood transfusions early in the epidemic and introduced screening procedures to detect and eliminate infected blood.
- In some developing countries, there is a continuing risk of HIV transmission through re-use of needles, through unsafe blood transfusions in health care settings and through some traditional medical practices that pierce the skin.

Figure 2.2 Notifications of new cases of HIV infection, 1992-2002  
National Centre in HIV Epidemiology and Clinical Research



affected homosexual men in Australia and only 10% of infections are in women, the majority through heterosexual contact. However, the proportion of women affected is higher amongst immigrants from sub-Saharan Africa and South-east Asia. HIV has not spread widely among IV drug users in Australia unlike many other industrialised countries.

Australia's public health response to HIV/AIDS is widely recognised for its effectiveness. It owed much to strong partnerships between affected communities, the government (across all jurisdictions and the political spectrum) and the scientific and medical community. These partnerships enhanced public awareness and led to the rapid and widespread adoption of safer sexual and injecting practice and minimised the stigmatisation of affected groups. More recently, as with the increase in notifications of gonorrhoea, chlamydia and HIV, there are concerns that the HIV epidemic might surge again in Australia because of a decline in safe sex practices. The apparent

rise in STIs could be due to complacency because of the availability of HIV treatment and because younger people, with no personal experience of AIDS deaths, are being recruited into groups practising risky behaviour.

## HEPATITIS VIRUSES

Two other viruses, also spread by direct contact with blood and body fluids, have recently assumed greater importance. These viruses are able to infect the liver and can cause long term liver damage and death. In the past the viruses spread through blood transfusion. Routine screening of all blood donors has prevented this method of spread. However transmission continues through other blood and body fluid contact.

### Hepatitis B virus (HBV)

HBV, first detected in 1965 in blood collected for research purposes in Australia, was initially named 'Australia Antigen'. Subsequently, the virus was shown to cause liver disease, liver failure and cancer of the liver (hepatocellular carcinoma), particularly in China and other Asian countries. In affected populations, HBV has passed from generation to generation by transmission from mother to child. Children infected early in life can carry the virus for

many years before developing the complications of liver failure or cancer in later life. HBV transmitted to an older person, either sexually, or through infected blood in a transfusion or a contaminated needle, can cause acute hepatitis or rarely, liver failure or liver cancer in subsequent years<sup>9 57</sup>.

When an effective vaccine for HBV became available in the 1980s, Taiwan was the first country to introduce infant vaccination to break the cycle of HBV transmission from mother to child. Infant vaccination will eventually prevent all cases of liver failure and liver cancer due to HBV in affected countries.

HBV was relatively uncommon in Australia except for people from high-risk countries and from some Indigenous communities. Nevertheless, by the 1980s there were increasing numbers of people developing hepatitis as a result of sexually transmitted HBV, or through contaminated blood. Risks from blood transfusion were eliminated by comprehensive screening. Infant vaccination was introduced first for children whose mothers had a high risk of being a carrier and then for all Australians. With these measures in place HBV should be eliminated from the Australian population in the longer term.



## Hepatitis C (HCV)

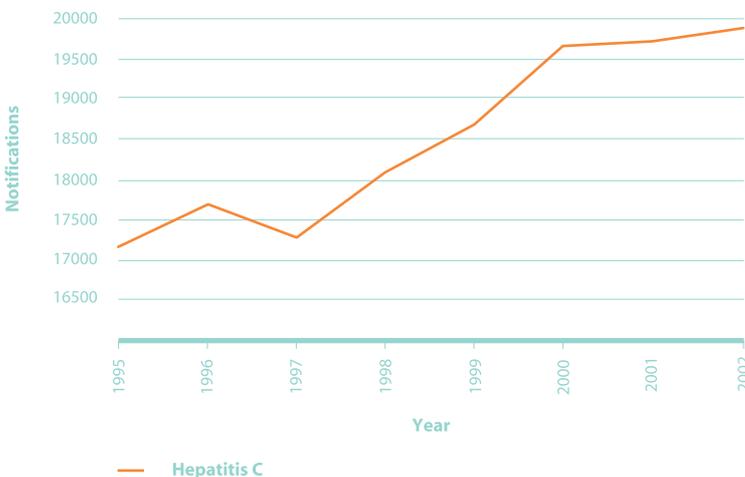
For many years it had been known that there were some cases of hepatitis in people who had received blood transfusion that were not due to HBV nor to hepatitis A, the form of viral hepatitis transmitted through contaminated food and water. In 1989 a new virus, named hepatitis C (HCV), was detected and shown to cause most of these “non-A non-B” post-transfusion cases of hepatitis<sup>9</sup>. HCV occurs in the blood of some 200,000 Australians (see Figure 2.3), many of whom are symptom-free<sup>55</sup>. Nevertheless, careful studies have shown that people with HCV can develop liver failure and cancer decades after they first acquire the infection. HCV is now one of the most frequent reasons for liver transplantation in some countries, including Australia<sup>58</sup>.

Because HCV mutates rapidly under selection pressure from the human immune response, it has not yet been possible to develop an effective HCV vaccine; experimental vaccines are now under trial. Fortunately, the treatment of hepatitis C has improved markedly in recent years, with the introduction of combination treatments with interferon and ribavirin. These drugs are expensive, but they can cure HCV infection in a substantial proportion of patients, thereby preventing the long-term complications.

Blood from hepatitis carriers is highly infectious. Without appropriate precautions it can spread through blood transfusions, on needles or on equipment used for body piercing or tattooing. Over 90 percent of hepatitis C infections in Australia are in people with a history of injecting drug use.

New HCV infections have been prevented by routine screening of blood donations. Infections can also be prevented by requiring sterilised equipment for body piercing or tattooing, by measures to reduce intravenous drug use and through needle and syringe exchange programs to avoid re-use of injecting equipment (see also Chapter 3). Nevertheless, because of the large number of Australians currently infected and the estimated 16,000 new infections per year hepatitis C will be a continuing burden in future years.

**Figure 2.3** Annual Notifications of cases of hepatitis C 1995-2002  
National Notifiable Diseases Surveillance Scheme



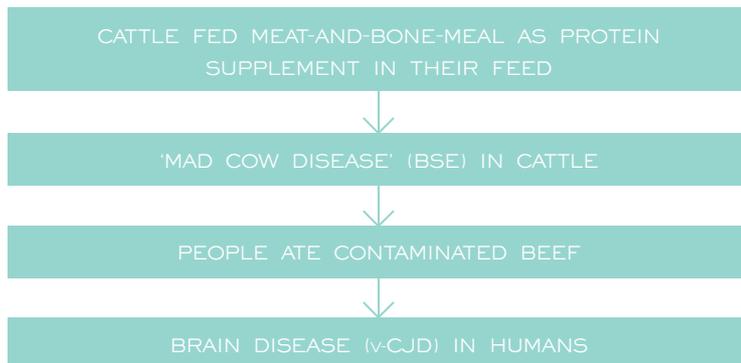
## THREATS FROM BSE AND v-CJD

'Mad cow disease', seen in Chapter One as an 'unintended consequence', is also a disease with low burden but high threat for Australia<sup>17 59</sup>. As of early 2004 there were no cattle affected with BSE and no cases of variant-CJD in Australia. Yet the threat remains. If it were introduced in cattle and humans there would be substantial health and economic costs and damage to public confidence. The disease in animals and humans results from the spread of an agent that is unlike other infective agents (see Table 1.1). The agent is a prion, an abnormally folded protein that can transmit the abnormality to others. These diseases, and other similar disease are called Transmissible Spongiform Encephalopathies or TSEs (see Table 2.1).



By early 2004 over 140 people with variant-CJD had been detected in the UK, six cases in France, with sporadic cases in Ireland, Hong Kong, Italy, Canada and the United States of America. By 2002 the number of new cases of variant-CJD detected in UK each year was no longer increasing and it seemed possible that the human epidemic had reached its peak, reflecting the successful measures taken previously in the UK to stop BSE-infected material from entering the human food chain.

Figure 2.4 A reminder of how v-CJD came to be....





Persons developing v-CJD outside the UK had mostly spent time in the UK during the BSE epidemic and had presumably been exposed to infected beef during that period. Australian cattle are recognised as BSE-free. This reflects our geographic separation from overseas epidemics, our

longstanding quarantine policies, the bans on meat-and-bone meal feeding introduced at an early stage and other measures (see Table 2.1). At some time in the future, we could see our first case of v-CJD from amongst the hundreds of thousands of Australians who were resident in the UK at some time during its BSE epidemic.

TABLE 2.1 HISTORY OF RESTRICTIONS TO PREVENT TSE'S FROM BECOMING ESTABLISHED IN AUSTRALIA

| Year | Action  |
|------|---|
| 1952 | Following an outbreak of scrapie in imported sheep, Australia banned the importation of live sheep and goats from all countries except New Zealand.   |
| 1966 | Australia imposed bans on imported stockfeed of animal origin from all countries except New Zealand. Locally produced meat-and-bone-meal (MBM) was fed to cattle until 1996.  |
| 1988 | Australia banned the importation of live cattle from the UK and Ireland and quarantined cattle already imported to prevent them entering the human or animal food chain.  |
| 1990 | A surveillance program began examining the brains of selected (sick) animals to look for BSE.   |
| 1991 | The ban on live cattle imports was extended to France and Switzerland.  |
| 1996 | Australian livestock industries adopted a voluntary ban on the feeding of ruminant- derived MBM to ruminants. Specified foods containing British beef and beef products were banned from importation into Australia.                                  |
| 1997 | The feeding of ruminant-derived MBM was outlawed by legislation in all States and Territories.  |
| 1999 | The ban on MBM was extended to cover the feeding of certain 'specified' mammalian material.   |
| 2001 | Australia suspended the import of beef and beef products from 30 European countries with active cases of BSE. Imports of beef and beef products from Japan were suspended in September 2001 following the confirmation of a BSE case in that country. |
| 2003 | Imports of Canadian beef and beef products were suspended in May following confirmation of a BSE case in Canada.  |

There are still many gaps in our understanding of BSE and v-CJD and the transmissible prion. The uncertainties faced by animal and human health authorities (see Box 2.7) are being considered by an expert committee of scientists established by NHMRC<sup>36</sup>. This Special Expert Committee on TSEs provides independent advice to health and agriculture portfolios, to quarantine authorities (AQIS) and to agencies responsible for the safety of foods (FSANZ) and therapeutic goods (TGA). For example, as prions can survive routine sterilisation, there is a risk that v-CJD could be transmitted from person to person through the re-use of contaminated surgical instruments, especially those used in operations on the brain or spinal cord, or eye. Organs such as tonsils also contain many prions. New approaches to sterilisation are being developed. Any risk to Australians of contracting v-CJD through medical procedures would be much less than the equivalent risk for UK residents.

The theoretical possibility that variant CJD could be transmitted from person to person through contaminated blood was realised in late 2003 with a report of vCJD in a person 6 years after receiving a blood transfusion from a donor who developed vCJD two years after making the donation in the UK. There is a very small risk that a person who lived in the UK during the BSE epidemic between 1980 and 1996 could be silently incubating v-CJD without symptoms. Because of this, Australia joined the US, Canada, New Zealand and Japan in excluding people from donating blood if they had lived in the UK for a total of 6 months or more between 1980 and 1996, or if they had themselves received a blood transfusion in the UK during that period.

Through the NHMRC expert committee<sup>60</sup>, Australia is carefully monitoring new international research on BSE and v-CJD and evaluating its relevance for policy and improved practice, in order to protect the health and safety of the Australian population.

#### *Box 2.7 Gaps in our knowledge about BSE and v-CJD*

- *How do prions produce disease?*
- *What treatments could delay disease in those infected?*
- *Can transmission of prions through surgery or transfusion be prevented?*
- *Can tests identify prions in a person incubating the disease, before they develop symptoms?*
- *Can prions be inactivated or destroyed more effectively (eg through enzyme treatment)?*



## THE NEW ERA OF THREAT

### CURRENT GLOBAL THREATS

There are several threats related to communicable disease that could endanger Australians. For example, if a disease emergency coincided with a global conflict or a major disruption of business, Australia

could be left with only limited access to essential vaccines and medicines from overseas. A number of communicable diseases could be introduced from overseas, re-emerge locally or otherwise threaten us (see Table 2.2). Fortunately, our vigilance and our public health measures have hitherto kept these diseases away from our shores or limited their local spread. SARS has been our most recent challenge<sup>20</sup>.



TABLE 2.2 CURRENT GLOBAL THREATS TO AUSTRALIA FROM COMMUNICABLE DISEASE

| Disease   | Threats  |
|---|--|
| SARS  | A new virus, potentially fatal, with high risk of transmission to unprotected health care staff.   |
| Pandemic influenza                                    | A devastating new strain could spread before a vaccine is available.   |
| Tuberculosis  | Tuberculosis control will be impeded if infections introduced from overseas are resistant to standard treatments.  |
| Malaria, dengue and Japanese encephalitis virus (JEV) | Could become permanently established in northern Australia where the mosquito vectors are already present.   |
| HIV/AIDS  | Complacency about "safe-sex" practices could lead to resurgence in transmission. Resistance to antivirals could compromise treatment; vaccines are not yet available.  |
| Hepatitis C   | Control of spread, largely via injecting drug use, is difficult. Needle exchange programs are effective in reducing risk behaviour and the transmission of blood borne viruses. There is no effective vaccine. New treatments are expensive. |
| Nipah virus   | Could be introduced from overseas into bat or animal populations. A potential threat to human health and to our pig industry <sup>9</sup> .  |
| Mad cow disease/ v-CJD                                | BSE would devastate the Australian beef export industry and increase the risk of v-CJD in people.  |
| Vaccine preventable diseases                          | Could re-emerge quickly if vaccination rates fall.   |
| Anti-microbial resistance                             | Some serious bacterial infections could become untreatable.  |
| Hospital acquired infections                          | Threaten increased morbidity, longer hospital stays and greater costs.   |

## SEVERE ACUTE RESPIRATORY SYNDROME (SARS)

In March 2003, following an alert from WHO, Australia woke to a new threat, Severe Acute Respiratory Syndrome<sup>20</sup>. SARS proved to be a previously unknown disease, a severe form of atypical pneumonia, caused by a novel virus that is like other viruses in the group of coronaviruses. (Previously known coronaviruses had caused less severe respiratory or gastrointestinal infections in humans or animals.) The SARS virus first affected humans in Southern China in November 2002. Subsequently, it spread in China, Hong Kong, Vietnam, Singapore, Toronto and Taiwan. There was local spread to health workers caring for patients, to family members and to others in the community.

SARS was carried from country to country through international air travel by infected people. By mid-2003, some 31 countries had reported cases of probable SARS. However, of the more than 8000 cases globally at that time, the large majority were in China, Hong Kong, Taiwan and Singapore. Except for Canada, there was almost no local transmission in countries outside Asia. By July 2003 the SARS outbreak was over, with some 8098 cases and 774 deaths reported to WHO.

Although some people are probably infected with the SARS virus without developing symptoms that lead to diagnosis, it is uncertain how often this occurs. For those admitted to hospital, SARS has a case fatality rate of some 14 percent; for those over 60, the risk of death is much higher. No treatment has yet proven to be effective, although the use of high dose steroids has been thought to delay the onset of respiratory failure and the need for assisted ventilation.

The international response to SARS has been impressive. Within weeks of the WHO alert, a consortium of international scientists and public health experts had isolated the novel virus, determined its RNA gene sequence and developed diagnostic tests and disease control measures. Australian experts worked with WHO in Geneva, Hanoi, Beijing, Singapore and Manila to develop and implement the international response. Within Australia, the Public Health Laboratory Network and other scientists pooled their expertise to develop locally validated diagnostic tests, with support from NHMRC.

### Box 2.8 Diagnosis of SARS

A person with SARS has:

- fever over 38°C
- cough and/or difficulty breathing
- lung X-ray showing atypical pneumonia
- the virus or antibodies against it detected by laboratory tests.

Health authorities were quick to recognise the very high risk of infection for health care workers exposed to sick patients shedding large quantities of virus. Tragically, in the early course of the epidemic, before stringent infection control procedures could be implemented, many health workers were affected and some died. Indeed, by bringing sick people into hospital without adequate precautions, more people may have been infected than if the sick patients had been managed at home.

### Box 2.9 A lost colleague

One of those who died from SARS infection in the Hanoi outbreak was Dr Carlo Urbani, the first WHO doctor to recognise SARS.



Senator the Hon Kay Patterson, Minister for Health and Ageing with the SARS team in the SARS Incident Room - April 2003



In Hong Kong in particular, many people were infected with SARS in the community. The very high population density (up to 70,000 people per square km) could have led to high rates of cross-infection when the virus was introduced. SARS was shown to spread predominantly through infected droplets and sputum, carrying very large amounts of virus. There was also a risk of transmission through faeces or urine. Nevertheless, the SARS virus did not appear to spread as easily as influenza, possibly because a larger dose of virus, from close contact, is needed to cause each new infection. People were most infectious when they were very ill and likely to be in bed. Unless such sick people were in hospital, they would be effectively isolated and less able to pass the virus on to other people. Studies in Singapore and elsewhere suggest that most SARS infections originated from a small number of highly infectious 'super-spreaders', who produce large amounts of virus (eg up to 100 million particles per ml of sputum)<sup>61</sup>.

Immediately after the WHO alert, the Commonwealth established an Incident Room, and the CMO worked with the quarantine authorities, with State and Territory health agencies and the Communicable Disease Network of Australia to enhance our border control and surveillance procedures. SARS was made a quarantinable disease. In partnership with infectious disease physicians and hospitals, stringent infection control procedures were introduced for patients with symptoms suggestive of SARS and a history of travel from an affected area. By early 2004 Australia was still free of life-threatening cases of SARS. However, because of the possibility of a new outbreak overseas, and because a person infected with SARS could enter Australia during the incubation period, Australia could still be at risk of SARS being introduced.

SARS reminds us that new diseases will continue to arise as infectious agents mutate and adapt to exploit new ecological opportunities. We cannot assume, as was widely trumpeted in the 1960s and 1970s, that we 'have conquered communicable diseases'. No-one can predict the next emergency, although we can all be wise after the event.

## TERRORISM- IS FEAR MORE DANGEROUS THAN DISEASE?

Today the world also faces potential threats from biological agents that could be deliberately released by terrorists. Such biological weapons cause fear in many people, perhaps even greater than fear of destructive weapons.<sup>62</sup> Why? Armaments are unfortunately familiar to many, even if only through portrayal in movies. Physical damage is immediate, palpable, visible and easily understood. Biological weapons have different effects and invoke a different fear. The agent may itself be invisible and its effects uncertain: damage may be delayed, or poorly understood. Panic may occur if we cannot exclude dreadful scenarios.

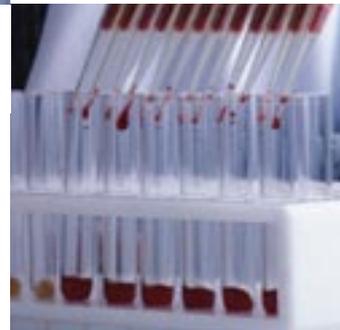
In 2001, a series of letters laced with finely milled anthrax spores infected 22 people and caused 5 deaths in the USA. Several people were infected indirectly from anthrax spores that escaped from letters into mail-rooms and other buildings. The resultant mass anxiety caused major social disruption: over 9,000 people were given antibiotics as a precaution in case they had been exposed to spores. Millions of dollars were spent to decontaminate buildings<sup>63</sup>.

Anxiety is natural, but panic brings added cost to the community, as well as advantage to terrorists. In the anthrax attacks, few were infected, most infected people were successfully treated and there was no chance of secondary spread from the human cases. We should remind ourselves that even at the height of the anthrax emergency in the US, the average risk of death from anthrax was far less than the risk of death from other every-day activities such as travelling by motorcar.

Following the anthrax attacks in the US, Australia and other countries saw a spate of 'copy-cat' hoaxes and reports of suspicious 'white powders' from fearful members of the public<sup>64</sup>. Emergency services and public health laboratories were strained by the need to investigate these many incidents and to exclude any risk of exposure to anthrax spores. The demands from these hoaxes and false alarms disrupted routine diagnostic and surveillance work. Fortunately, as the public became less anxious and as the media stopped reporting these incidents, they stopped happening.

## Understanding biological threats can help

Biological agents have limitations as weapons. A better understanding of their effects and limitations can help ameliorate the fear of the unknown. In fact, the strategies to detect and control deliberate biological threats are similar to those used by the public health community in dealing with natural biological agents in their day-to-day business of communicable disease control. The clues for detection of a biological attack (see Box 2.10) are similar to the clues used by the public health system in detecting normal outbreaks of disease.



### Box 2.10 Clues\*

*A biological attack could be suspected if there were:*

- *a single case of a rare disease (eg a single case of smallpox anywhere in the world or a single case of plague, tularaemia or viral haemorrhagic fever in Australia),*
- *cases of unexplained disease or death or of disease in an unusual age group (eg cases of severe 'chicken pox' in adults),*
- *unusual symptoms for a disease (eg suggesting pulmonary anthrax),*
- *a disease in an unusual location (eg cholera in an Australian with no history of travel and no contact with a recently travelled person),*
- *a disease that is normally transmitted by a vector that does not live in that area,*
- *an unexpected outbreak or epidemic with unexplained symptoms,*
- *several simultaneous epidemics in different locations,*
- *serial epidemics of different diseases in the same population,*
- *unusual strains or variants of an organism or similar genetic types of organisms at different locations (eg the same anthrax strain causing sporadic disease in different countries).*

\* Modified from CDC<sup>63</sup>

## Scientific assessments of biological threats

The USA Center for Disease Control and Prevention (CDC) has ranked biological agents that could be used as weapons, taking account of the severity of disease, the potential for the organism to spread and the disruption and panic that could be caused<sup>63</sup>. They also considered the public health infrastructure that would be needed to react quickly and effectively to contain an outbreak. Category A agents (Table 2.3) were those with the highest risk and the highest priority in warranting plans for protection (Appendix 6 give more details).

However, category A agents are not readily available to terrorists. For example, smallpox no longer occurs naturally and the virus is only held legally by Russia and the USA<sup>62 63</sup>. Anthrax is a natural disease of animals, but it is technically demanding to produce spores of the type used in the USA attacks. Plague, tularaemia and viral haemorrhagic fever do not occur in Australia, but reference stocks of the agents have been held in public health and research laboratories overseas. Access to stocks has recently been tightened through legislation in the USA and through international agreements co-ordinated by WHO. What was once

a simple process to obtain a reference culture of an organism is now strictly controlled. The success of any biological weapon attack is also limited by the survival of the agent on dissemination, by its capacity to spread from person to person and by measures available for early detection, defence, prevention and treatment.



Frank Fenner - who chaired the WHO Commission to eradicate smallpox, demonstrating vaccination on an apple.

TABLE 2.3 CATEGORY A AGENTS OF BIOTERRORISM — CHARACTERISTICS AND LIMITATIONS

| Disease                   | Availability of agent     | Spread to others | Hardy | Prevention                             | Prevention if exposure known  | Treatment                     |
|---------------------------|---------------------------|------------------|-------|--|-------------------------------|-------------------------------|
| Smallpox                  | Very limited              | Yes              | No    | Vaccine                                | Vaccine within 4 days         | Antivirals & immunoglobulin   |
| Anthrax                   | Moderate                  | No               | Yes   | Vaccine – limited to high risk workers | Vaccine and antibiotics       | Antibiotics                   |
| Plague                    | Limited                   | Yes              | No    | Vaccine for bubonic form, Antibiotics  | Vaccine and antibiotics       | Antibiotics                   |
| Botulism                  | Reasonable                | No               | Yes   | Vaccine – limited to high risk workers | Antitoxin                     | Antitoxin                     |
| Tularaemia                | Very limited in Australia | Yes in theory    | Yes   | Vaccine being investigated             | Antibiotics                   | Antitoxin                     |
| Viral Haemorrhagic Fevers | Very limited              | Rare             | No    | Vaccine for some                       | Antiviral medication for some | Antiviral medication for some |

The difficulties of mounting a successful biological attack are shown by the experience of Japanese religious cult, Aum Shinrikyo. The cult was well-resourced, but its attempts to prepare weaponised anthrax from soil samples were unsuccessful, as were its attempts to weaponise botulinum toxin and Ebola virus. As many as a dozen germ attacks were attempted in Japan from 1990 to 1995. All were unsuccessful<sup>62</sup>.

## PREPAREDNESS

### SURVEILLANCE AND OUTBREAK CONTROL

Surveillance is the means by which we monitor disease, detect outbreaks and plan local (see Box 2.11) or national (see Box 2.12) action. Through routine surveillance we can assess whether our control strategies are keeping known diseases at bay and also recognise any new disease threats that emerge. The surveillance system in Australia, using multiple approaches to detect cases, is closely linked to disease control activities<sup>65</sup>. Surveillance depends primarily on the alertness of doctors and laboratories making diagnoses of communicable disease. Reporting of notifiable diseases (see Appendix 5) to health agencies within each State or Territory is required under public health legislation. Local officials take immediate action to investigate and

control local outbreaks. In addition, each jurisdiction sends de-identified data to the National Notifiable Diseases Surveillance System<sup>65</sup> administered by the Commonwealth, to allow for the detection of national trends, the detection of outbreaks crossing state borders and for cooperative national action.

#### *Box 2.11 Local action following detection*

*In 2001 eight children in one local area were notified as having diarrhoea from Cryptosporidium infection. Previously outbreaks due to Cryptosporidium had been traced to contaminated water supplies, swimming pools or to products such as apple juice. In this outbreak local public health workers showed that affected children had drunk unpasteurised milk, labelled as pet milk, contaminated with Cryptosporidium. Clearly the milk did not meet the appropriate food standard.*

*This outbreak could have been much larger if the milk had been more widely consumed.*

This system provides Australia with a solid base for communicable disease surveillance. In the future more sophisticated methods of surveillance will provide rapid, real time, reporting of data and detection of disease. While the National Notifiable Diseases Surveillance System incorporates data about known diseases, newer surveillance systems may detect clusters of people with particular symptoms. For example, emergency room databases can be searched for combinations of symptoms relevant to diseases of interest. Such surveillance methods are being further developed in pilot programs.

#### *Box 2.12 National action followed detection*

*In the mid-1990s many cases of measles and other childhood diseases were reported under the National Notifiable Diseases Surveillance Scheme. As these diseases are prevented by prior vaccination, the upsurge in diseases was a warning that the proportion of vaccinated children had fallen dangerously low. In 1997, Commonwealth and State Governments embarked upon Immunise Australia, with a Seven Point Plan to increase vaccination coverage. There were new incentives for families and doctors, an extensive school-based measles, mumps, rubella immunisation campaign and a new register to measure vaccination uptake. The success was clear. By 2002 Australia had its lowest measles notification rates on record. Vaccine coverage for all children had increased and over 90% of one year olds were 'fully immunised'. In 2003, the rates were even higher.*

FIGURE 2.5  
SURVEILLANCE OF  
COMMUNICABLE  
DISEASE



\* Activities co-ordinated by State, Territory and Commonwealth agencies through the CDNA, the National Immunisation Committee, and the National Public Health Partnership.

Fortunately, Australia has a well-trained work-force for communicable disease surveillance and control, thanks to the forethought of public health leaders in the 1980s and training programs such as the Master of Applied Epidemiology funded by the Commonwealth<sup>66</sup>. There is also funding for complementary training programs from some States and Territories. Since 1989, State, Territory and other national experts have met together as the Communicable Diseases Network Australia (CDNA) for disease control purposes. Members convene fortnightly by tele-conference, to exchange information about communicable disease activity in Australia, New Zealand and the Pacific islands. Since 1997 The Public Health Laboratory Network (PHLN) has provided national expertise for laboratory diagnosis to support communicable disease control, as well as reference capacity for the diagnosis of rare and exotic infections.

Investigations of outbreaks of diseases are important for disease prevention. Such investigations seek the source of an infection (eg contaminated food or a contaminated water tower) and show how transmission can be stopped. Investigations also look for people exposed to a source, or those who may have had contact with a disease carrier. Individuals at risk can be offered prevention (eg vaccination for measles contacts or antibiotic prophylaxis for contacts of patients with meningococcal disease) or early treatment. Outbreak investigation also provides new understanding about sources of infection and how those infections are transmitted. Such investigations also promote public and professional awareness. Lessons learned are fed back into education about disease control and help to prevent future outbreaks.

Public health responses to national outbreaks, such as the 1999 outbreak of typhoid in passengers who had returned from a sea cruise to Papua New Guinea, are coordinated through CDNA. With national outbreaks, as occurred in the typhoid investigation, it is important that investigators in each jurisdiction use consistent protocols. Those 'on the spot' will continue to also use their expertise to identify infection sources and transmission pathways and to adapt preventive responses and clinical management of outbreaks to suit local conditions.

#### Box 2.13

##### Outbreak or epidemic?

*We use the terms 'outbreak' and 'epidemic' where there are more cases of a particular disease than expected for a given time, place and population. In general usage, an epidemic is considered to be larger in size than an outbreak and to have a longer time-frame.*



## PREPAREDNESS FOR BIOTERRORISM AND OTHER EMERGENCIES<sup>64</sup>

The public health expertise of PHLN and CDNA, supported by the clinical awareness and expertise of infectious disease experts and other doctors, provides Australia with the capacity to recognise and respond to any covert bioterrorist attack at the earliest possible time. Both CDNA and PHLN played a large role in the management and investigation of the 'white powder incidents' in 2001. The CMO has also sought specialist advice from expert doctors and scientists to finalise detailed plans for responding to particular threats such as smallpox and anthrax. Government responses are coordinated with the Department of Defence, Emergency Management Australia and the Protective Security Co-ordination Centre. Particular attention is given to the necessary infrastructure, including the response capacity of hospitals, laboratories and emergency services. The ability of the different agencies to respond in a coordinated manner is tested in scenarios and trial exercises. The Australian health sector has also distributed guidance to doctors about bioterrorist threats and responses.

The Australian Health Minister Advisory Council (AHMAC) recently established the Australian Health

Disaster Management Policy Committee to improve national health disaster preparedness. The Department of Health and Ageing chairs and provides the Secretariat services for the new committee. Its membership includes a senior health official from each Australian State and Territory as well as experts in public health, mental health, clinical care and emergency services. The Australian Defence Force, Emergency Management Australia and a senior health officer from New Zealand are also members of the new Committee. In the event of an incident that requires a national health response, the Commonwealth will consult members of the committee to form a response group to co-ordinate the national response to the incident.

The timeliness of reports of disease and the capacity of our laboratories across the nation are also under review. WHO has recommended that authorities develop contingency plans to deal with bioterrorist events, natural communicable disease outbreaks and other public health emergencies. Australian expertise, linking to WHO and CDC overseas, helps to support regional and global preparedness as well as protecting our own population. The National Influenza Pandemic Action Committee provides advice to government on influenza pandemic preparedness with reference to the *Australian*

### Box 2.14 Human Quarantine A Proclamation of an Epidemic

#### 2B Proclamation in the event of epidemic

(1) Where the Governor-General is satisfied that an epidemic caused by a quarantinable disease or danger of such an epidemic exists in a part of the Commonwealth, the Governor-General may, by proclamation, declare the existence in that part of the Commonwealth of that epidemic or of the danger of that epidemic.

(2) Upon the issue of a proclamation under subsection (1) the Minister\* may, during the period the proclamation remains in force, give such directions and take such action as he or she thinks necessary to control and eradicate the epidemic, or to remove the danger of the epidemic, by quarantine measures or measures incidental to quarantine.

#### 2A Power to supersede Quarantine measures under State Acts

(1) Whenever the Governor-General is satisfied that an emergency exists which makes it necessary to do so, he or she may, by proclamation, declare that any or all measures of quarantine prescribed by or under any State Act shall, for such period as is specified in the proclamation, cease to have effect and such measure shall thereupon cease to have effect accordingly.

\*The Minister administering the Department that deals with human quarantine

*The Quarantine Act 1908*

### *Action Plan for Pandemic Influenza.*

The Action Plan specifies the roles and responsibilities of the Commonwealth, State and Territory governments to ensure that Australia is well prepared, and has the capacity to manage in the event of an influenza pandemic.

If an epidemic of influenza, or a bioterrorist event, were to be detected and considered as a national emergency, the powers of the Quarantine Act could be used by Commonwealth health authorities to apply a national approach to the control of an epidemic. The powers of the Quarantine Act would be applied through State and Territory health authorities under the direction of the Commonwealth Chief Medical Officer and in co-operation with other Commonwealth and State and Territory government agencies.

In responding to SARS, countries overseas placed many contacts of SARS patients into home isolation or quarantine to prevent the further spread of the disease. Some countries used coercive powers, while others relied on voluntary compliance. In Australia, the few people requiring home isolation or hospital quarantine because of the possibility of SARS were managed under voluntary arrangements. Fortunately, it was not necessary to consider using the coercive powers under State or Commonwealth legislation.

## CONCLUSIONS

Low burden/ high threat is not new for Australia. We will always be at risk from communicable disease outbreaks that are 'natural', as well as those that may be deliberate and malicious. In its preparations, Australia has many advantages. As an island nation, we can readily quarantine imports and more readily monitor incoming travellers for symptoms and for any contacts with disease outbreaks overseas. As a centre of expertise for our region, we are able to work cooperatively with neighbouring countries and provide advice and technical support that will not only help them with disease control matters, but also help to give Australia early warning of problems arising in the region.

National investigation of outbreaks is co-ordinated by the Communicable Disease Network Australia, well experienced in surveillance and disease control. Comprehensive laboratory expertise to identify microbes that cause disease is provided through the Public Health Laboratory Network. Other experts have also advised the Chief Medical Officer and other agencies on biological security. In any infectious disease or biosecurity emergency the Quarantine Act also provides special powers to enforce internal quarantine nationally. Fortunately, such a proclamation, on advice from the Chief Medical Officer, has never yet been needed.

