



Australian Government  
Department of Health and Ageing

DEPARTMENT OF HEALTH AND AGEING

PROTECTING AUSTRALIA FROM

# COMMUNICABLE DISEASES:

EVERYBODY'S BUSINESS



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# COMMUNICABLE DISEASES: EVERYBODY'S BUSINESS



## A SPECIAL REPORT FROM THE COMMONWEALTH CHIEF MEDICAL OFFICER

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Richard Smallwood

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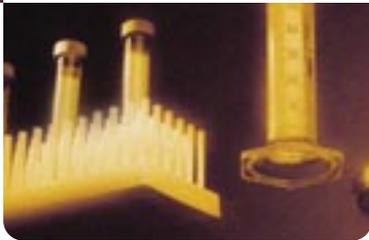
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# CONTENTS



<b>FOREWORD .....</b>	<b>vii</b>
<b>PREFACE .....</b>	<b>1</b>
<b>CHAPTER ONE : UNINTENDED CONSEQUENCES .....</b>	<b>6</b>
<b>THE MICROBIAL PERSPECTIVE.....</b>	<b>6</b>
Microbial transmission and disease severity.....	8
Climatic and geographic influences .....	8
<b>EFFECTS OF SOCIAL CHANGE .....</b>	<b>9</b>
Historic effects of settlement .....	9
Conquest, trade and travel .....	11
Human influences on microbial habitats.....	12
Refugee camps, slums and shanty towns .....	12
Risks for children and older people .....	13
Intensive production of food .....	13
Changing food trends .....	14
<b>SUCCESSES &amp; LIMITATIONS OF MEDICAL SCIENCE .....</b>	<b>15</b>
Magic bullets .....	16
Medical and surgical advances also generate risks.....	17
Benefits and risks of research.....	18
<b>CONCLUSIONS .....</b>	<b>19</b>
<b>CHAPTER TWO: LOW BURDEN ..... HIGH THREAT .....</b>	<b>20</b>
<b>THREATS THAT HAVE LONG BEEN WITH US .....</b>	<b>20</b>
Influenza .....	20
Tuberculosis .....	22
Malaria and other vector-borne diseases.....	23
Sexually transmitted infections (STIs) .....	25
<b>THREATS THAT HAVE BEEN MORE RECENTLY RECOGNISED .....</b>	<b>26</b>
Human Immunodeficiency Virus (HIV) and AIDS.....	26
Other blood borne viruses .....	27
Threats from BSE and v-CJD .....	29
<b>THE NEW ERA OF THREAT .....</b>	<b>32</b>
Current global threats .....	32
Severe Acute Respiratory Syndrome (SARS).....	33
Terrorism, is fear more dangerous than disease?.....	34
<b>PREPAREDNESS.....</b>	<b>37</b>
Surveillance and outbreak control .....	37
Preparedness for bioterrorism and other emergencies .....	40
<b>CONCLUSIONS .....</b>	<b>41</b>



<b>CHAPTER THREE: EVERYBODY'S BUSINESS .....</b>	<b>42</b>
<b>IDENTIFYING RISK .....</b>	<b>42</b>
<b>REDUCING RISK.....</b>	<b>43</b>
Safer food and water .....	43
Vaccination .....	45
Preventing mosquito bites .....	47
Practise safe sex .....	47
Use sterile equipment if injecting .....	48
Question the need for an antibiotic .....	48
Engage infection control .....	49
Prevent 'hospital acquired infection' .....	51
<b>INVOLVED COMMUNITIES .....</b>	<b>52</b>
Consumer participation in decision making .....	52
Maintaining trust in the wider community.....	53
<b>BALANCING COMMUNITY AND INDIVIDUAL INTERESTS .....</b>	<b>54</b>
<b>CONCLUSION.....</b>	<b>55</b>
<b>CHAPTER FOUR: LOOKING BACK, LOOKING FORWARD .....</b>	<b>56</b>
<b>WHERE ARE WE NOW?.....</b>	<b>56</b>
Global burden of communicable disease .....	56
How is Australia situated? .....	56
Learning from the past and the present .....	57
<b>REALISING THE FUTURE .....</b>	<b>58</b>
Global knowledge - experts and the media .....	58
Technology will give new understanding and new tools .....	60
Public health and clinical skills .....	61
<b>INVOLVING THE PUBLIC .....</b>	<b>61</b>
Public understanding, trust and confidence .....	61
Public values and leadership .....	62
<b>CONCLUSION.....</b>	<b>63</b>
<b>GLOSSARY .....</b>	<b>65</b>
<b>APPENDICES.....</b>	<b>67</b>
Appendix 1 Vaccines for disease prevention .....	67
Appendix 2 Chronology of scientific and public health advances in communicable diseases .....	70
Appendix 3 Communicable disease control and research selected Australian events and contributions .....	72
Appendix 4 Distribution of resistance to antimicrobials and chemotherapeutic agents .....	74
Appendix 5 Diseases included in the National Notifiable Diseases Surveillance Scheme .....	76
Appendix 6 CDC categorisation of possible agents of biological attack.....	77
<b>FURTHER READING AND REFERENCES .....</b>	<b>79</b>

# FOREWORD

This special report from the Chief Medical Officer is important and opportune. Encouraged by my predecessor Senator Patterson, this report presents facts about communicable disease in straightforward language. The report will help the Australian public to understand new diseases such as SARS and variant-CJD, as well as continuing problems such as HIV. Readers will also see how pandemic influenza could re-emerge and how serious infections could make a come-back as bacteria become resistant to our powerful antibiotics. Furthermore, in the new era of terrorism, there is the possibility that microbial agents, new or old, might be spread deliberately. Such possibilities threaten public confidence and economic growth as well as health.

To be forewarned is to be forearmed. Australia is well served by highly trained health professionals, with measures in place for effective disease surveillance and control that would also provide early warning of any possible bioterrorist threat. Australia has a proud record of achievement in medical research and development. Some of our best minds are being recruited to advise government and to devise new means for prevention, early detection and treatment of communicable disease.

The facts and ideas in this special report will inform future thinking and planning for communicable disease control and enhance our level of preparedness. With better understanding, Australians in the wider community will be more able to protect themselves from infection. They will understand that in protecting themselves, they are protecting others. Decision-makers outside the health portfolio will also come to consider the unintended health consequences of their decisions and actions. They will better understand how health threats, such as SARS, can impact on public and business confidence. The media will be more engaged in communicable disease issues, promoting discussion to strike the right balance between individual rights and public good when these are in conflict.

In the years to come, the Australian community will have many reasons to thank Professor Smallwood for his leadership in commissioning and overseeing the project and the Editorial Advisory Committee and the many experts who have contributed to it. I welcome the report and congratulate all those involved in its planning and production.

Tony Abbott

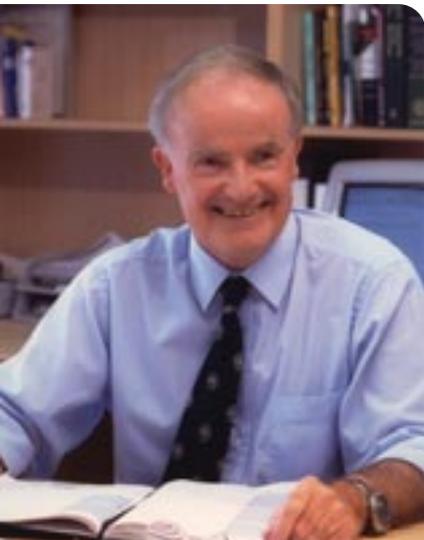
**Minister for Health and Ageing**



# PREFACE

I present to you a unique report envisioned by Professor Richard Smallwood during his term as Chief Medical Officer of Australia. This is a book for all Australians, from school students, government and industry workers to retirees. Communicable diseases will continue to threaten populations, a threat best managed by knowledge, understanding and action. Professor Smallwood's vision provides the backbone for all Australians to grasp and embrace control of infectious diseases, both known and new.

Professor John Horvath  
Chief Medical Officer



Professor Richard Smallwood, Chief Medical Officer  
1 November 1999 - 30 June 2003

**'A dance to the music of time'**  
Anthony Powell

The title of Anthony Powell's major, life-long work is an apt metaphor for the relationship between humankind and the microbes that cause communicable diseases. We have evolved with microbes over countless millennia. Our relationship will continue into the future to be hazardous and unpredictable.

Most of us have some understanding of the historical importance of communicable diseases. In past centuries, diseases such as plague and smallpox could suddenly appear to threaten the very survival of some civilisations. Yet few of us understand why communicable diseases are still a problem and why new diseases will continue to emerge, despite the advances of medical science and the implementation of public health and hygiene measures.

This report, 'Protecting Australia against Communicable Disease: Everybody's Business' is designed to help the Australian public to understand these challenges from infectious diseases. Until recently, people might reasonably have been asked: 'Why worry? Haven't we in this country been on top of communicable diseases for decades now?' Yet after the emergence of HIV/AIDS in the 1980s there has been a gradual re-awakening of concerns about communicable diseases around the world. There have been accounts for the lay reader<sup>1</sup> as well as reports such as those from the National Institute of Medicine in the USA<sup>2</sup>, and the Chief Medical Officer in the UK<sup>3</sup>. A sense of urgency has been engendered by the anthrax attacks in the USA, by 'white powders' here and by the global emergence of SARS.

Australia was independently aware of these emerging problems. In 2001 I convened an editorial group and invited contributions and suggestions from many communicable disease experts to help us develop this special report. After producing several lengthy draft documents, we came to the view that Australia would be best served by a short and engaging report for the general public<sup>4</sup>, and references for those in need of more detailed information.\*

\* References and web-site addresses are listed on p78.  
A short glossary is also provided on p65 to help the non-technical reader.



The underlying messages of this short report are simple. First, if Australians understand more about communicable diseases, they will be better able to protect themselves through good hygiene, safe-sex, vaccination and the prudent use of antibiotics. Second, many communicable disease problems, including SARS, BSE, variant-CJD, HIV and hospital acquired infections, are the unintended consequences of changes in human society and behaviour. Third, because microbial agents causing communicable disease can evolve quickly to exploit new opportunities, or to escape our interventions, we cannot predict how they will change and we may never finally win the arms race against them. Fourth, with global threats from terrorism, there is the possibility that microbial agents, new or old, might be spread deliberately. The risks are low, but we have already seen, following the anthrax attacks in the USA and the white powder 'false alarms' around the world, how fear can cause public alarm that is out of proportion to the real threat.

The rest of this preface summarises the main themes and conclusions of the report, the most important of which is that the control of communicable diseases requires constant vigilance now and into the future.

## CHAPTER ONE: UNINTENDED CONSEQUENCES

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Why can't we conquer communicable diseases once and for all? The answer is that in our rapidly changing world, many communicable diseases can be viewed as unintended consequences of changes in our own behaviour. The microbes causing communicable disease are able to evolve incredibly quickly to exploit new opportunities and to subvert measures that were previously effective against them. Changes in human society, both historical and contemporary, have led to the emergence of new diseases and the re-emergence and spread of some old ones. Measles, influenza, tuberculosis, HIV and SARS all originated from animal microbes that then adapted to spread amongst humans. Influenza and other 'crowd diseases' spread rapidly in overcrowded urban environments, particularly if hygiene was poor. Global epidemics of HIV/AIDS and hepatitis C emerged as a result of rapid transport, changes in work arrangements, sexual habits, intravenous drug-use and medical practice. Many bacteria spread easily to vulnerable patients in a hospital environment. Two generations of antibiotic use for trivial reasons have given a selective advantage to those microbes that are resistant. Consequently, some

serious bacterial infections can no longer be cured by antibiotics that would have been effective in the past. The use of bovine meat-and-bone-meal as food supplements for cattle ('bovine cannibalism') triggered the BSE epidemic in UK cattle, with subsequent spread to people as variant-CJD.

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

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Australia is still a lucky country. The burden from communicable diseases is much lower here than in developing countries. With good public infrastructure, an educated population and well-trained health professionals, life expectancy in Australia increased by almost 30 years during the 20<sup>th</sup> century, largely because of declining infectious disease mortality. We now take our low infectious disease burden for granted, but we must thank our many experts, working behind the scenes to keep old and new diseases under control. Nonetheless, many diseases could still threaten us.

Past generations were more aware of communicable diseases. In 1918 – 1919, a global influenza pandemic killed at least twenty million people, including many thousands in Australia; many more fell ill, health services were disrupted, with widespread public

alarm. Influenza virus is a continuing global threat because it can spread easily and evolve rapidly to elude our prevention and treatment strategies.

Previous generations of Australian families faced the real possibility that their children would succumb to childhood illnesses such as diphtheria, whooping cough, measles and infantile paralysis (polio). Such diseases, now prevented by childhood vaccination, could return promptly if vaccination rates are allowed to fall.

Australia did not escape the global epidemic of HIV/AIDS, but by dint of prompt and far-sighted public health measures, we escaped with a lower rate than in most other countries. Yet the threat remains. HIV is still life-threatening, despite the availability of new treatments in countries such as Australia. Our rates of HIV transmission are rising again, possibly due to unsafe sex amongst younger generations with no direct experience of AIDS. Other sexually transmitted infections, such as chlamydia and gonorrhoea, are rarely life threatening, but they can cause serious disease or infertility.

Hepatitis C, a major cause of chronic liver disease and cancer, is also a looming public health threat. It had infected over 200,000 Australians by 2003, with a continuing risk of blood-borne infection through needle-sharing and unsafe procedures for skin-piercing and tattooing.

Other global diseases of historical importance could still threaten us. Australia has been free of local malaria since the 1960s. Yet in 2002, mosquitos in northern Queensland bit a person who had acquired malaria in Africa, and transmitted it to nearby campers. Fortunately, further spread was averted by swift public health action. Tuberculosis (TB) infections kill 2 – 3 million world-wide each year and can be difficult to treat if the microbe resists the usual antibiotics. If such resistant TB is introduced here, local infections would be costly and difficult to cure.

Health authorities and researchers also work to protect Australia against new disease threats recognised overseas. When variant-CJD (v-CJD) was identified in people who had eaten BSE-contaminated beef in the UK, Australia banned imports of food and therapeutic goods that could pose a risk of transmission of v-CJD. In 2003, the Australian burden of BSE and v-CJD is still zero, but the threat remains. The world had another scare early in 2003 when the SARS virus was spread from southern China to other countries by air travellers, infecting many thousands, with many hundreds of deaths. Fortunately, Australia's border control, surveillance and infection control measures have helped to protect us from SARS.

The world is now facing a new era of threat from infections or toxins that may be deliberately spread by terrorists. Fortunately the chance of such a biological attack is small. Furthermore, the principles for outbreak detection and management, well rehearsed for other communicable diseases, would apply equally to deliberate attacks. With its measured responses, Australia will keep the public informed, to help ensure that fear of the unknown does not cause concern that is disproportionate to the small level of risk.

## CHAPTER THREE: EVERYBODY'S BUSINESS

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All of us have a responsibility to prevent communicable diseases from spreading. We rely on government, industry and each other for the safety of our food and water supplies. We know that a simple breakdown in hygiene can lead to diarrhoea or hepatitis for the individual, or even trigger a large outbreak of food-borne disease. We know that rejection of vaccination can threaten the life of an infant exposed to a serious disease such as whooping cough or expose an unborn child to catastrophic damage from rubella virus. Moreover, for every family that rejects vaccination, the level of herd immunity will fall, increasing the risk that the microbe can re-emerge and

spread to infect all those who are not immunised. If an individual ignores safe sex messages, there is a risk of sexually transmitted infections, not only for that person, but also for future partners. Sharing of syringes by intravenous drug users or unsafe tattooing or skin-piercing practices will spread blood-borne viruses such as Hepatitis C. Where vulnerable or dependent people come closer together, as in hospitals, nursing homes or child-care centres, microbes are more able to spread from person to person. Indeed, microbes can be inadvertently carried around by health-care workers and attendants unless there is scrupulous attention to hygiene and infection control precautions. Many Australian parents can speak with feeling about otitis media and other infections that young children bring home from day care.

Why do we continue to behave in ways that spread disease and expose others to risk? Knowledge of transmission risks is not enough to modify behaviour. Even health care workers, presumably well informed about infection risks, can do the wrong thing; overseas, many health care workers were infected in the SARS epidemic as a result.

As individuals and as a society, we implicitly balance risks against benefits. Governments and health

authorities are working to ensure that health workers and the public are aware of disease risks and individual responsibilities. They also provide guidance about risk management, with appropriate incentives to reduce risks, as with the family allowance payments to encourage vaccination. Authorities also work tirelessly with expert groups to protect the public through border control and quarantine, surveillance and outbreak control, vaccination, safe food and water, good health care and through research.

The community also searches for the balance between individual rights and public benefit in communicable disease control. Ideally, individuals should be free to decide on the risks that they take for themselves. Unfortunately, personal acceptance of a communicable disease risk, such as unsafe sex or refusal of vaccination, will add to the risks for others. Disease control also requires that patients with dangerous diseases such as SARS are isolated, or that larger numbers of contacts remain in quarantine until the incubation period has passed. In our modern world, such restrictions on personal freedom are difficult to accept, yet they may be essential. The media can play a very positive role in promoting public discussion of such issues.

## CHAPTER FOUR — LOOKING BACK, LOOKING FORWARD

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History has taught us the multiple ways in which human behaviour influences disease transmission, emergence and evolution<sup>5 6 7</sup>. To enjoy long-term protection against communicable disease, we need to continue to learn from past and future threats.

The situation of Indigenous Australians today is salutary. They still suffer from infectious diseases that were largely eliminated from the rest of Australia in the previous century. If Indigenous health is also to benefit, albeit belatedly, this will require good education, communication and understanding, improved infrastructure and administration, improved food and water supplies and facilities for hygiene, behavioural change and better health services.

For all Australians there will continue to be important health benefits from the better distribution and application of existing knowledge to solve problems such as hospital-acquired infection and antibiotic resistance of bacteria. Benefits will also flow from improved surveillance, in cooperation with international authorities, to ensure the earliest possible detection of new or re-emerging infections such

as SARS or influenza. With more consultation between health and non-health sectors, Australia will be better prepared to minimise the damage to public confidence and business activity that can flow from communicable disease threats. Decision-makers outside the health sector will also be able to foresee any unintended health consequences of changes within their spheres of responsibility.

Public confidence will be enhanced through more media discussion of the implications of communicable diseases for the future of society. Educators and scientists can work together to promote more widespread community understanding of risk assessments and decision-making. We must also be prepared to acknowledge uncertainty about risk and unintended consequences. For example, we know that medical

and scientific advances enabling increasingly complex surgery, transfusion of blood and blood products, intensive care and anti-cancer treatments have been of great benefit to individual patients. However, we also know that these advances have made more people vulnerable to serious infection.

Our future will be increasingly driven by social and technological change and the world needs the best available science to keep ahead of the challenges from communicable disease. Australia is fortunate in having deep expertise in biological science. We will thus be well situated to use the fruits of medical research we already know about and to bring forward new research. For example, Australian researchers have developed new treatments for influenza, which could be very important in any future pandemic. Australian

research has also underpinned a new vaccine against papillomavirus, which could prevent the sexually transmitted infections that lead to cervical and other genital cancers. Australians can be reassured that we will continue to use our best minds for the public good.

The details and examples in the full report should be of great interest to you. I hope you will take the time to read it, to discuss it with your friends and colleagues and to think about its implications for yourself, your family and your personal and work responsibilities.

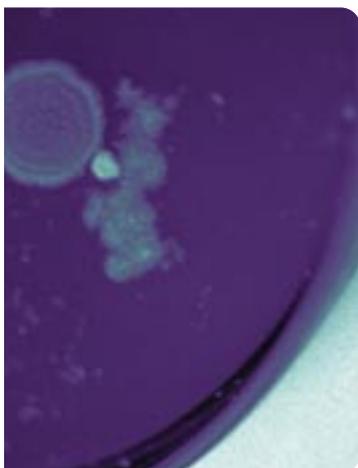
In facing an uncertain future from communicable diseases, our best strategy is to ensure that the community is well informed and that our scientists and health professionals continue to be well trained and supported. Such plans really are everybody's business.

Richard Smallwood  
Chief Medical Officer 1999 - 2003



# CHAPTER ONE: UNINTENDED CONSEQUENCES

Humans have suffered from communicable diseases since the dawn of history, but it is only in the last few generations that we have understood the science behind infections and been able to control spread of infectious disease. With understanding has also come the belated realisation that many human actions have had unintended consequences for communicable diseases. This chapter explores how changes in human society and behaviour have provided new opportunities for microbes to evolve and cause disease.



## THE MICROBIAL PERSPECTIVE

---

Micro-organisms (microbes) exist, not to cause infection in humans, but simply for their own survival<sup>6</sup>. Indeed, bacteria existed on earth for three billion years before there were any plants or animals as potential hosts. A microbe can only survive within a human host if it can find a place to grow, compete effectively with other microbes and survive the person's immune defences. Only a few of the microbial and parasitic species around today can colonise humans and of these, only some cause human disease; the remainder colonise the skin, bowel, or respiratory tract as commensals that rarely cause harm<sup>7</sup>. The range of agents that can cause communicable disease is summarised in Table 1.1<sup>8,9</sup>. Bacteria can grow in many situations, while viruses cannot multiply outside a living cell of another host organism. Parasites are heterogeneous and vary greatly in size; they typically have life cycles that are very complex.

How do bacteria and other microbes adapt to new hosts and new opportunities? Through random genetic change over generations, all living organisms are able to evolve and adapt. One generation for humans is perhaps 25 years, whereas a single generation for a microbe can be as short as 20-25 minutes. Microbes, with such rapid multiplication, thus can adapt very quickly. The natural forces that drive microbial evolution are selective; only the fittest microbes survive. If a new genetic mutation allows a microbe to better exploit its environment, the mutant has an advantage over sister microbes without that mutation. Thus any microbe that can grow more quickly, evade immune defences, hide in the host, be transmitted more effectively, or resist antibiotic treatment, will win the competition to survive.<sup>6,7,8</sup>



TABLE 1.1 AGENTS CAUSING COMMUNICABLE DISEASE

Type of agent	Size	Genetic material	Examples of disease
Prions	Protein molecule only a few nanometres* across	None- consists only of protein	Mad cow disease, Creutzfeldt-Jakob disease
Viruses	Ultramicroscopic (up to 200 nm*)	RNA or DNA	Common cold, influenza, cold sores, smallpox, polio, measles, AIDS, hepatitis C
Bacteria	Microscopic (about 1000 nm)	DNA	Tuberculosis, diphtheria, tetanus, pneumonia, wound infections
Fungi	Aggregates of microscopic cells	DNA	Thrush, ringworm, tinea
Parasites	Variable-from microscopic plasmodia of malaria to tapeworms up to 10 metres long	DNA	Malaria, tapeworms, hydatids, schistosomiasis (or other flukes)

\* A nanometre (nm) is 10<sup>-9</sup>metre (ie one billion nm to the metre)  
 • For more details see Mims et al<sup>8</sup> or Chin<sup>9</sup>

Changes in a host population such as overcrowding, changes in hygiene, medical practice including antibiotic use, intravenous drug use, or changing sexual networks, can act as selective forces. Such influences drive a microbe into a new evolutionary niche<sup>7</sup> where it is possibly more transmissible or more virulent (dangerous) for humans.

Mutations that are advantageous in one microbe can also be transferred to other strains or species. For example, the genetic information (DNA) that allows a bacterium to resist an antibiotic can be transferred within and between bacterial species. For some bacterial species the transferred gene is in an infectious circle of DNA (a plasmid). For others, the transferred DNA is recombined into the bacterial chromosome<sup>8</sup>. Even though such transfer may only occur rarely, the receptive bacterium will spread widely in an environment, such as a hospital, where antibiotic resistance gives it a selective advantage<sup>10</sup>.

**Box 1.1 Natural selection**

*Studies of microbial evolution using genetic fingerprinting (DNA and RNA gene sequences) provide the most direct evidence for Charles Darwin's epoch-making idea of evolution by natural selection.*

## MICROBIAL TRANSMISSION AND DISEASE SEVERITY

The success of a microorganism's long-term survival is dependent on its ability to spread and survive rather than its capacity to cause severe disease. The common cold is a minor illness. The symptoms, sneezing and coughing, ensure that cold viruses are spread through droplets onto new hosts and into the air. Thus the viruses causing cold continue to infect many people without immobilising those affected.

In contrast, severe infections leave the patient bedridden, reducing the ability to spread the microbe to others. Smallpox is one example; if a patient is bedridden, only those who are closest can get the disease. Measles is another. If acquired in the home, measles tends to be more severe<sup>11</sup>. If measles is acquired from outside the home it means a person with measles is well enough to be out and about and spreading disease. It is probably a milder form of disease that enables the spreader to be in contact with others. With a severe disease the person would be bed-ridden and only able to spread infection to those in their home. People at home may also get a larger dose of viruses because of their close contact. Paul Ewald has noted that ambulant patients with cholera may transmit bacteria that are less virulent and that the resultant selection pressures could help to explain the evolution of milder forms of the disease<sup>7</sup>.

## CLIMATIC AND GEOGRAPHIC INFLUENCES

Smaller organisms are very sensitive to climatic conditions. Many microbes and parasites have adapted to warm and humid environments. A whole discipline of medicine is devoted to the diseases of the tropics caused by infective agents (malaria, yellow fever, schistosomiasis, dengue, flukes and worms etc), some of which are transmitted by 'vectors' such as mosquitoes, ticks and water-snails (see Box 1.2). Tropical diseases are endemic where parasites and vectors can survive year round in a climate that is warm and usually moist<sup>12</sup>. Mosquito reproduction,

survival and biting rates are all influenced by temperature, rainfall and humidity. Furthermore, the infectious agents that actually cause tropical diseases, such as the malarial plasmodium or dengue fever virus, also grow more quickly as the temperature rises.

In temperate climates, outbreaks of food poisoning, caused by bacteria such as *Salmonella* and *Campylobacter*, are more frequent in summer than winter months<sup>9</sup>. Influenza tends to occur in the cooler months. Infections such as tuberculosis can occur year-round<sup>9</sup>, although air-borne transmission is inhibited by sunlight, which rapidly inactivates most bacteria and viruses.

### Box 1.2 Flukes of nature<sup>12</sup>

*Unlike the common use of the word fluke, the disease-causing flukes, seen in tropical countries, are anything but a 'fortuitous chance happening'. They are a type of worm that parasitises people. For example, Schistosomiasis is caused by one group of flukes, that settle in the liver, intestines, kidneys, lungs or brain. How do they get there? When an animal or person excretes the eggs of a fluke in their urine, faeces or sputum, the egg hatches in water and enters snails. After living in the snail, free-swimming forms of some flukes directly invade human skin. Others invade aquatic plants, fish or crabs that are then eaten by people. Once in the body the flukes travel through the skin and blood stream and mature into adult worms in the liver, intestine or kidney to send out their eggs and complete the complex life-cycle.*

Flukes currently infect more than 200 million people in many tropical countries, causing many deaths and considerable disability.

## EFFECTS OF SOCIAL CHANGE

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### HISTORIC EFFECTS OF SETTLEMENT

When humankind lived in small hunter-gatherer bands, there would often have been too few susceptible individuals to allow disease-causing microbes to survive long-term within the band. This is because affected individuals either became immune or died and did not spread the microbe to many others. Microbes that could survive long-term in such circumstances were those such as *E.coli* in the bowel which evolved as commensals, rarely causing harm<sup>7</sup>. With the rise of horticulture and agriculture and the domestication of animals in the last 10,000 years, the ecology of infectious disease changed. Most serious human infections of recent times, including influenza, tuberculosis, malaria and plague are of animal origin – what Diamond calls ‘the lethal gift of livestock’<sup>13</sup>. Tuberculosis, originally acquired from domesticated cattle, learnt to survive long-term within the human body and to spread from person to person.

Furthermore, the larger groups of people supported by horticulture or agriculture presented a sitting target for disease vectors such as mosquitoes, for organisms transmitted through human excreta or for organisms harboured by animals and pests such as rats<sup>13 14</sup>. Human malaria appears to have evolved from malaria in birds and monkeys to become established in human populations in Africa<sup>7 13</sup>.

Crop surpluses were traded. Grain attracted rats and trade helped to spread them around the civilised world. Rats were likely to be infected with plague and rat fleas helped to spread the plague from rat to rat, from rats to people and from person to person<sup>13 14 15</sup>.

#### Box 1.3

*Communicable diseases have been present throughout human history*

*Most communicable diseases are acquired from other humans:*

- *by droplet infection or by direct contact,*
- *indirectly by (faecal) contamination of food and water supplies,*
- *via insect or animal vectors or needles that pierce the skin.*

*Diseases of humans have often evolved from diseases of animals and some have:*

- *been particularly dangerous when first transmitted to humans,*
- *evolved to spread from person to person.*

*Human behaviours influence communicable disease transmission and evolution through:*

- *changes in the natural environment,*
- *agricultural and animal husbandry practices,*
- *global distribution of food supplies,*
- *travel, trade and warfare,*
- *crowding in camps or cities, providing opportunities for cross infection or contamination of food or water supplies,*
- *poor hygiene*
- *sexual networks and lifestyle,*
- *intravenous drug use and other skin-piercing practices,*
- *medical practices (cross-infection, chemotherapy, transfusion, transplantation).*



As cities developed, crowding and poor hygiene allowed the spread of microbes causing 'crowd' diseases affecting the respiratory and gastro-intestinal tracts. Diarrhoeal disease was an unintended consequence of drinking water being drawn from streams contaminated with faeces. Science eventually came to the rescue with John Snow's recognition in 1854 that cholera was spread through water supplies. Other 'crowd' diseases such as mumps, measles and chicken pox were able to thrive. City populations supported by agriculture were large enough to maintain ongoing transmission of many infectious diseases, with, from time to time, major epidemics<sup>15 16</sup>.

TABLE 1.2 COMMUNICABLE DISEASE CONSEQUENCES OF SOCIAL CHANGE

Social changes	Consequences
Domestication of animals	Microbes from animals adapt to infect people, causing diseases such as tuberculosis and measles
Rise of agriculture providing food for larger population aggregated in cities	Diarrhoeal, respiratory and other infections spread more easily in crowded and unhygienic conditions
Food distribution systems to feed large populations	Widespread food-borne disease outbreaks
Hospitalisation	Cross-infection causing surgical infections and child-birth fever in historic times. Contemporary hospital infections with bacteria resistant to antibiotics
Unsterile needles for injection	Spread of blood borne disease in health care institutions and in illicit drug users
Changes in acceptance of sexual practices and networks; global travel; men who have sex with men; men living away from home for work	Global spread of HIV, with growing epidemics in Africa and Asia
Clearance of forests	Bats move to seek new homes and spread Nipah virus to pigs; virus spreads from pigs to humans <sup>9</sup>
Feeding of bovine meat-and-bone-meal to cattle	BSE in cattle, variant CJD in humans <sup>17</sup>

## CONQUEST, TRADE AND TRAVEL

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In recent millennia, the first contacts between two different civilisations have exposed one population to new infections from the other<sup>13 14 15</sup>. This phenomenon led to the decimation of those historical populations which could not resist infections to which they had not previously been exposed. The Antonine smallpox plague in the 2<sup>nd</sup> century AD was introduced to Rome by the legions returning from Syria. Smallpox devastated much of the city and the empire to the west. It has been argued that this epidemic, as much as the aggression of the barbarian tribes, led to the decline and eventual fall of Rome. Similarly catastrophic was the Black Death or bubonic plague which arrived in Europe in the 14<sup>th</sup> century when Genoese merchants, fleeing from attack by Mongolians in the Black Sea, returned home with rats and their infected fleas on board their ships. Over the next generation bubonic plague killed one third of Europe's population.

The arrival of 'European' microbes in the New World was equally devastating. How was it possible for Cortez and his 600 Spaniards to defeat the mighty Aztec Empire in 1520? The answer was probably smallpox. Most of the Spaniards were immune from previous

exposure, but the smallpox they introduced killed half the Aztec population, including the emperor. A similar fate awaited the Incas in Peru a few years later. In North America in the 15<sup>th</sup> and early 16<sup>th</sup> centuries, large Native American populations living in major settlements had inhabited the Mississippi Valley. By the late 17<sup>th</sup> century those communities had virtually disappeared, wiped out by 'European' microbes to which they had never previously been exposed. These organisms had spread overland following the arrival of Columbus in the Americas in 1492 and the subsequent arrival of European settlers on the East Coast.

In Australia from the late 18<sup>th</sup> century, the previously unexposed Aboriginal population was even more vulnerable because of disruption of social structures and food supplies. Smallpox, typhus, typhoid, measles and whooping cough all wrought havoc<sup>18 19</sup>. A smallpox epidemic occurred soon after the First Fleet arrived in Port Jackson in 1788. Although the origin of the outbreak was never identified, the infection could have come from 'variolous matter' brought by ship's surgeons. This was eight years before Jenner's discovery that 'cowpox matter' could protect against smallpox. In 1831, Indigenous people in the Liverpool range of NSW were

affected by a virulent smallpox outbreak that was controlled by vaccination. The pattern was to be repeated in subsequent generations.

In modern times, increased world travel has provided many opportunities for diseases such as HIV, influenza<sup>1 10 15</sup> and SARS<sup>20</sup> to spread quickly from country to country. Indeed, with fast travel many people previously exposed to an infection can arrive in another country before they have themselves developed symptoms, making it difficult to stop the entry of a new disease at the border. International travel has also spread antibiotic resistant bacteria causing health-care associated infections to hospitals across the world<sup>21</sup>. Resistant staphylococcal strains from UK hospitals are indistinguishable from those in eastern Australia. The consequences of our globalisation and travel are clear.

With increasing travel and tourism and with many students from tropical countries studying in Australia, malaria and other vector borne diseases are increasingly diagnosed in Australian hospitals. In northern Australia, with a permissive climate and vectors, there is the further risk that tropical diseases such as malaria and dengue could become permanently re-established<sup>22</sup>.

## HUMAN INFLUENCES ON MICROBIAL HABITATS

Many human activities have provided new environments and opportunities for harmful microbes. For example, many outbreaks of deadly Legionnaires disease have been recognised since humans first began to install water-cooled air-conditioning systems. The causal microbe, *Legionella*, previously restricted to its natural aquatic environments, could thrive in this new ecological niche. When dispersed in aerosol form from the air-conditioner, the microbe could be inhaled to cause severe pneumonia or death in vulnerable people. The first recognised outbreak affected a group of elderly US veterans attending an American Legion reunion in Minnesota in 1957<sup>9</sup>. Australia has not been spared from this disease. For example, there was a large outbreak at the Melbourne Aquarium in 2001<sup>23</sup>.

The clearance of forests to build an international airport in Malaysia in the 1990s led to a devastating outbreak of Nipah virus, carried by forest bats fleeing to agricultural lands. The bat virus, relatively harmless to them, spread to pigs and from them to humans, with deadly effect. The epidemics were stopped only after millions of pigs were slaughtered in 1998-9<sup>9</sup>.

Large dams, irrigation schemes, land reclamation, road construction and population resettlement programmes – notwithstanding their other economic and social benefits – have sometimes helped to spread diseases such as malaria, dengue fever, schistosomiasis and trypanosomiasis.<sup>5,9</sup> In the Sudan, for example, schistosomiasis appeared within several years of the start of a large irrigated cotton project<sup>5</sup>. Today, there are concerns that the China's Three Gorges Dam project could promote local transmission of schistosomiasis and malaria.

## REFUGEE CAMPS, SLUMS AND SHANTY TOWNS

Disease spreads readily in crowded conditions; close contact facilitates the spread of microbes spreading via respiratory secretions and faeces. If water supplies are poor and sewerage inadequate, hygiene suffers and infections become rife. This explains higher rates of infection in shanty towns, slums and in refugee camps where crowding is extreme and services inadequate<sup>24</sup>.

Refugees dislocated by war, as in Rwanda, can bring numerous infectious agents of diverse origin. In overcrowded conditions everyone can be exposed, usually to multiple agents. Undiagnosed or poorly treated dysentery, tuberculosis, hepatitis A and parasitic diseases can spread readily. Health workers struggle to prevent deaths from acute respiratory infections, diarrhoea, measles, malaria or other conditions. Malnutrition facilitates infection leading to a vicious cycle of decreased appetite, wasting and worse malnutrition in young children. With war, or political and social instability from other causes, many refugees are not vaccinated. Outbreaks in refugee camps can potentially lead to outbreaks of measles and rubella or other vaccine-preventable diseases beyond the refugee community. War can drive a cycle of deprivation, leading to further unrest and conflict, with many ongoing consequences for communicable disease.

### *Box 1.4 Eastern Zaire, 1994*

*Death rates when migration is forced are usually high. The exodus of almost one million Rwandan refugees into eastern Zaire in 1994 resulted in death rates more than 30 times greater than rates prior to the conflict. Severe cholera and dysentery epidemics were seen in the first month after the influx.*

## RISKS FOR CHILDREN AND OLDER PEOPLE

Crowded conditions are not limited to developing countries or to disadvantaged minorities in developed countries. The needs of families have led to group care arrangements for children and for some older persons in countries such as Australia; the resultant contact and crowding can spread communicable disease. Children in child care settings are particularly prone to communicable disease because of immature immunity, close contact with each other and limited personal hygiene. Australian research<sup>25</sup> has shown how such children can be better protected from communicable diseases by implementation of the Australian guidelines: 'Staying Healthy in Child Care'<sup>26</sup>.

Elderly people are also vulnerable to infectious diseases as their immunity declines with age. This disease burden can be reduced by improved vaccination coverage, particularly for influenza and pneumococcal pneumonia, by effective and prudent use of antibiotics in primary care, by enhanced surveillance and by improved infection control in aged care institutions<sup>27</sup>.

## INTENSIVE PRODUCTION OF FOOD

New and 'efficient' methods of production of livestock and poultry have also had unforeseen consequences. Chickens reared in intensive conditions have feed that is supplemented with antibiotics to promote growth and to treat and prevent disease. Unfortunately such antibiotic use has favoured the survival of bacteria that are resistant

to antibiotics. Bacteria in chickens that are resistant to antibiotics can spread directly to people and cause infections that are hard to treat. Furthermore the genes for antimicrobial resistance can also spread to other bacteria that infect humans.

The feeding of meat-and-bone-meal as a protein supplement to cattle to promote growth has had even more disastrous consequences<sup>17</sup>. The outbreak of 'mad cow disease' (Bovine Spongiform Encephalopathy

### Box 1.5 Cannibalism, Kuru and CJD

*In the 1950s, a fatal nervous disease (kuru) was recognised amongst the Fore people in the Eastern Highlands of New Guinea. The epidemic of kuru was shown to have spread by ritual cannibalism of those who had previously died from the disease. In the 40 years after cannibalism ceased, the epidemic has subsided.*

*Kuru has been shown to resemble Creutzfeldt-Jacob Disease (CJD), a rare but fatal disease of older people. Both diseases could be transmitted to animals by affected brain tissue. Unfortunately, before the risk was recognised, CJD was also inadvertently transmitted to patients receiving hormones or grafts made from infected tissues.*

*Kuru, CJD, BSE and variant-CJD are all now known as Transmissible Spongiform Encephalopathies (TSEs). The infective agents are prion proteins.*



A boy with Kuru in 1966 - probably infected as a toddler in the late 1950s. His hand is trembling - an early sign of the disease.



or BSE) first recognised in UK in 1986<sup>17</sup>, was caused by the feeding of meat-and-bone-meal prepared from cattle carcasses back to cattle. In the light of the kuru story (see Box 1.5 and<sup>28</sup>), this cycle of 'bovine cannibalism' might have been anticipated to cause trouble. Health authorities in the UK reassured the public and the world, well into the 1990s, that BSE was unlikely to 'jump species' and affect people. They were proven wrong when a new fatal human disease, variant-CJD, with 'spongiform' changes in the brain similar to those of BSE

infection and kuru, was recognised in 1996. By 2003, some 130 cases of variant-CJD had been diagnosed in UK, predominantly in younger people thought to have eaten BSE-contaminated beef at the height of the BSE epidemic<sup>29</sup>.

## CHANGING FOOD TRENDS

All foods, but particularly those that are moist, or contain meat or seafood, can nourish bacteria if they become contaminated; dangerous bacteria multiply rapidly in a warm environment. Prevention of food-borne disease is straightforward in principle. Adequate cooking kills most microbes, but does not fully inactivate the prions that transmit TSE. Preservatives, drying and refrigeration inhibit bacterial growth<sup>30</sup>.

Yet some members of our younger generations have forgotten the food hygiene principles from the past. Furthermore, new food trends, demands for fast foods and for foods without preservatives have radically changed food supply chains and introduced new risks.

Food-borne diseases have re-emerged with a high profile in the last few years. Outbreaks affect public confidence in health authorities, yet the tried and tested methods of the past are losing acceptance. The promotion of 'health' and 'natural' foods creates pressure to remove the preservatives (eg salt, nitrite, sugar or others) from food that were originally introduced to reduce microbial growth. Preservative-free food products, at clear risk of microbial contamination, can cause large outbreaks, even across international borders<sup>30</sup>.

### Box 1.6 New trends in food

Recent changes in food supply include:

- natural/health foods without preservatives,
- 'take-aways' or 'fast food',
- 'cook-chill' (pre-cooked and cold-stored),
- 'sous vide' (vacuum packaged products which consumers cook in their plastic pouches),
- large processing plants and
- international traffic in fresh foods.

### Box 1.7 'Preservative Free'

Outbreaks of gastro-enteritis or food-poisoning from bacterial contamination of preservative-free "dips" and other foods have been reported internationally.



## SUCCESSSES & LIMITATIONS OF MEDICAL SCIENCE

In 1796, Jenner had shown that vaccination with pus from cowpox, a mild disease, could protect against subsequent infection with deadly smallpox. By the 20<sup>th</sup> century, his insight had spawned the science of immunology, leading to vaccines against whooping cough, tetanus, polio and other deadly diseases<sup>14 15</sup>.

Infection control principles date back to the work of Oliver Wendell Holmes in USA, James Simpson in Britain and Ignatz Semmelweiss



A younger **Gus Nossal**, at the time of succeeding Frank Macfarlane Burnet as Director of the Walter and Eliza Hall Institute in Melbourne. The success of Australia's research in immunology and vaccine development owes a great deal to his leadership and personal contributions.

in Vienna. Long before the responsible microbe (*Streptococcus pyogenes*) had been identified, they showed in the 1840s that doctors who did not wash their hands spread deadly 'childbirth fever' to women in obstetric hospitals. Yet it was not until the 1890s, following the acceptance of 'germ theory' and the work of Joseph Lister, that infection control measures were routinely introduced into obstetric and surgical practice<sup>14</sup>.

### Box 1.8

*'It may seem a strange principle to enunciate as the very first requirement of a hospital that it should do the sick no harm.'*  
(Florence Nightingale, 1863)

Penicillin was discovered accidentally when a mould, blown through Alexander Fleming's laboratory window in 1928, produced an antibiotic that killed bacteria growing on a culture plate. By the 1950s, antibiotics such as penicillin had made most bacterial diseases treatable and therefore much less threatening<sup>14</sup>.

### Box 1.9 Penicillin history<sup>15</sup>

*The mould, *Penicillium notatum*, killed staphylococcal bacteria and led Fleming to identify the antibiotic properties of penicillin.*

*An Australian, Howard Florey, working in Oxford, proved the value of penicillin and ensured its place in history in the early 1940s. Fleming, Florey and Chain later won the Nobel Prize for their work on penicillin.*

*Fleming was also one of the first to recognise that antimicrobial resistance would be a problem. Only recently has the magnitude of the problem and Fleming's prescience, become widely understood*

With vaccines, infection control and antibiotics, we thought we had won the war with communicable disease. More than 30 years ago, the then US Surgeon General stated that 'the time has come to close the book on infectious diseases'. Hindsight is a great teacher and the last three decades have taught us that there will be no closing of books on infectious disease, now or ever.

Nevertheless, we have learnt much since the 19<sup>th</sup> century. The concepts underlying public health prevention, antisepsis, asepsis, immunisation and treatment have evolved from vague ideas into the powerful technologies of today (see Appendices 1 to 3). In the overall march of health, an important lesson is that preventive strategies are still more effective than curative approaches.

## MAGIC BULLETS

It is hard now for people to recall the world before antibiotics, when many people died from infections. In 1941, Florey and Chain purified penicillin and showed its dramatic effects against pus-forming bacteria such as streptococci. Deaths from infected war wounds were greatly reduced following large-scale manufacture and use of penicillin in the latter years of World War 2. In civilian use, penicillin led to striking reductions in death or disability from childhood fever, scarlet fever, syphilis, meningitis, pneumonia, osteomyelitis and many other infections. Since 1945, penicillin is estimated to have saved at least 50 million lives. Treatment of tuberculosis with streptomycin, isoniazid and para-amino-salicylic acid and other anti-microbials was similarly successful<sup>15</sup>.

### *Box 1.10 Selective advantage and antibiotic resistance<sup>7 10</sup>*

*Although genes for antibiotic resistance have existed for aeons, the human use of antibiotics has given the genes for resistance, through the microbes that carry them, a great evolutionary advantage. When sensitive bacteria are inhibited by antibiotics, resistant bacteria thrive and take over the living space.*

*Antibiotic resistance is more likely to emerge if the antibiotic dose is low or interrupted, as bacteria with partial resistance can survive to accumulate new mutations or new genes for increased resistance.*





We were confident for many years that we could easily deal with resistance to antibiotics because there was always another antibiotic in reserve. We have been proven wrong (see Appendix 4). Since the 1940s, antibiotics have been applied uncritically to the treatment of many minor conditions rather than being reserved for serious and life-threatening bacterial infections. They have also been used, unwisely, for viral infections for which they are not effective. Harmless bacteria in the skin and the bowel, as well as bacteria that can cause disease, were thus needlessly exposed to antibiotics. Genes conferring resistance to antimicrobial agents have thus spread quickly.

Doctors had acquired the habit of prescribing antibiotics and found it difficult to change. In 1974, Lockwood described a syndrome of compulsive antibiotic prescribing (CAP) and suggested formation of Antibiotics Anonymous to deal with the problem<sup>32</sup>. Although light in heart, the message was blunt. Yet we took little heed.

The problem of antibiotic resistance has been compounded, since the 1950s, by the widespread use of antibiotics in intensive animal production. Antibiotics were added to stock feed to treat and to promote rapid growth of chickens, pigs and other animals housed under intensive conditions. Such agricultural uses selected for resistant bacteria in animal populations and increased the risk that such a bacterium could spread into human populations, or that a resistance gene could spread into bacteria able to infect people.

Overuse of antibiotics in medicine and agriculture has thus spread bacteria carrying genes for antibiotic resistance<sup>33</sup>. If a resistant bacterium causes disease, it can now be difficult to find an antibiotic that will be effective. Recently one of our last line antibiotics, vancomycin, became ineffective against some strains of 'golden staph' (*Staphylococcus aureus*). The staphylococcus acquired the resistance gene (called *vanA*) from a bowel microbe (*Enterococcus*)<sup>34</sup>. The problem of antibiotic resistance has now attracted international attention. Australian responses to antimicrobial resistance are summarised in Chapter 3.

Antiviral drugs are now available to combat infections caused by viruses such as influenza, herpes, HIV and hepatitis B and C<sup>9</sup>. The lessons from overuse of antibiotics will guide their future use. It is already known that HIV mutates very quickly and that resistance to antiviral agents can emerge quickly.

## MEDICAL AND SURGICAL ADVANCES ALSO GENERATE RISKS

We have seen great strides in medical and surgical management of disease. Patients with debilitating joint disease, or organ failure, can be treated by surgical replacement of a joint or by transplantation of a new organ such as a liver. However all medical and surgical procedures can have unintended consequences. The mere fact of bringing vulnerable people close together in a hospital increases the risk that infection will spread from one to another. Since the time of Semmelweis we have known that hospital staff can carry such infections from patient to patient. Subsequent generations have shown how difficult it can be to achieve full compliance with hand-washing and other infection-control procedures in the complex environment of a busy hospital<sup>35</sup>.

Health-care associated infections are increasingly common because of the vulnerability of sick patients, because complex surgical treatments open up many portals of entry for infection, because of the accumulation of antibiotic resistant bacteria in hospital and because of cross-infection risks. Such infections of patients cause significant illness and death, at considerable economic cost<sup>35</sup>. Many are preventable through effective infection control interventions (see Chapter 3).

In developing countries, with less well-resourced health systems, there are additional risks. Outbreaks of exotic infections such as Ebola have been seen in African hospitals. In some countries, the re-use of needles and syringes, or the use of unsterile blood equipment has transmitted HIV, hepatitis C or other infections to patients in hospital or outpatient clinics.

Hospital staff are also at increased risk of infection in developed countries. HIV or hepatitis B and C can be spread through accidental (needle-stick) injuries involving needles previously used for infected patients. Most infectious diseases, but notably tuberculosis and SARS, can also spread from infected patients to health staff caring for them.

#### *Box 1.11 Hospitals spread Ebola and SARS*

*In Africa, hospitals amplified two outbreaks of Ebola, a disease caused by a virus spreading through re-use of syringes and needles in 1976 and through poor hygiene in 1995. Seventy-six medical staff were infected in the first weeks of the 1995 outbreak. Following improved hygiene, barrier nursing and patient isolation only one other worker became infected<sup>19</sup>.*

*Hospitals in developed countries are also at risk as seen with the rapid spread of SARS to health care workers in Singapore and Toronto<sup>20</sup>.*

## **BENEFITS AND RISKS OF RESEARCH**

The sciences of microbiology, epidemiology and immunology have already provided impressive tools for communicable disease treatment and control. Genetic engineering of microbes has provided even more possibilities for improved diagnosis, new vaccines, rational drug design and for other advances. Indeed, in the world of the future, Australia is very well situated to exploit new technology for public benefit. NHMRC<sup>36</sup> and other research agencies already support talented Australian medical researchers, with a proud record of achievement in communicable diseases and immunology (see also Chapter 4 and Appendices 2 & 3). The Department of Education, Science and Technology, through the Australian Research Council, the Commonwealth Cooperative Research Centre Program and the CSIRO, has also supported Australian research expertise of relevance for communicable diseases.

However some research can also have unintended consequences. For example, genetic manipulation of the mouse-pox virus recently created a new virus able to kill mice that were immune to the original mouse-pox virus<sup>37</sup>. This example underlines why Australia has a rigorous and transparent risk assessment process for all genetically modified organisms. Humankind has opened Pandora's Box of genetic science and technology.

In realising the future benefits of research, Australia must also plan to minimise the risks. Fortunately, regulatory procedures are already in place<sup>38</sup>. Scientists, alert to the possibility of such unforeseen consequences, are already working on solutions. Nevertheless, the public has a right to be informed of the issues and to be reassured that the precautions are adequate and that the net benefit of such research will continue to advance the public good.

## CONCLUSIONS

Communicable disease control has hitherto been successful through the public health reforms to create healthy environments, through infection control and through scientific discovery of vaccines, antibiotics and other treatments. Improved public administration and education, clean water supplies and sanitation, improved nutrition and personal hygiene, better housing and working conditions led to dramatic reductions in death and disease in the generations born after 1850, with increased survival of infants and children, increased life expectancy and improved quality of life. Science and public health have made many advances.

Nevertheless, changes in human society have also given rise to many new problems in communicable diseases. For each unintended consequence of our actions, we have sought to find a solution. Sometimes the solutions themselves have led to other risks. For example, in response to our introduction of antibiotics, microbes have adapted with genes that resist their effects.

### *Box 1.12 The Red Queen Principle*

*In any evolutionary system, continuing development is needed just to maintain fitness relative to any competitor. This principle, from L. van Valen in 1973<sup>39</sup>, is named from the observation to Alice in Lewis Carroll's "Through the Looking Glass". As the Red Queen said: "in this place it takes all the running you can do to keep in the same place."*

This race between us and the microbial world, as epitomised by the "Red Queen"<sup>39</sup>, is likely to be never-ending. Microbes will always be able to evolve quickly to exploit the gaps in our armoury and in our defences against them.

Life can never be risk free and our medical scientists and public health professionals must be prepared and supported to keep abreast of the microbial challenges that will arise in future years and generations. Furthermore, with the burgeoning of new scientific knowledge comes the additional responsibility of keeping our society informed about the known benefits and risks of new

treatments and interventions. Along with the balance of benefit and risk that we can see now, we need to also consider unintended consequences that may be unforeseen and even unimaginable. The lesson from history is clear. Any action we take, regardless of whether we see it as health-related, can have an impact on communicable disease.



Image courtesy of <http://www.scholars.nus.edu.sg/victorian/graphic/tenniel/lookingglass/2.4.html>

# 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

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### 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

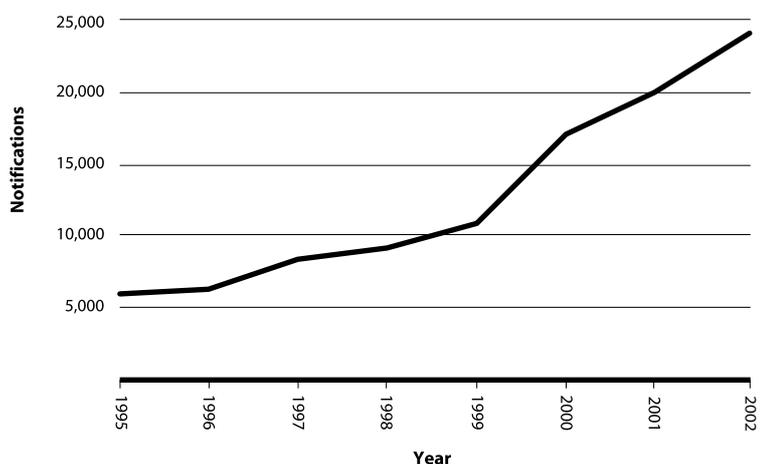
War 1, there was a small cohort of Australians with chronic syphilis affecting the brain and spinal cord or blood vessels. After World War 2 however, the risks were greatly reduced because of penicillin treatment. Today, syphilis lingers on only in those with restricted access to health care. If a mother 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.

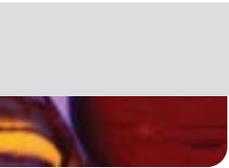
Gonorrhoea, with inflammation and discharge from the urethra or vagina, tends to be less painful in women and is thus more likely to go untreated than in men. Untreated infections can damage the female reproductive tract, leading to pelvic pain and even to infertility, or to uncommon but life-threatening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

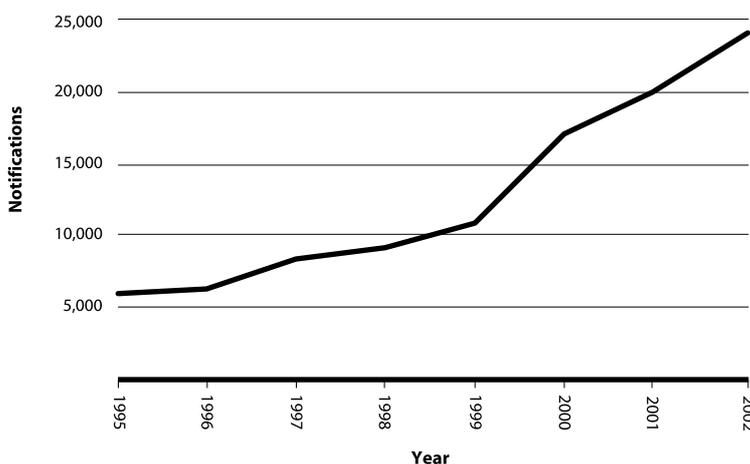
The human immunodeficiency virus (HIV) is predominantly a sexually transmitted infection, but it can also be transmitted by blood contact<sup>8 9 53 55</sup>. In the early stages, persons with HIV infection are usually symptom-free. However, when untreated, HIV attacks a part of the immune system (T-lymphocytes) 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 2.1 Notifications of cases of chlamydia infection 1995 - 2002**  
National Notifiable Diseases Surveillance



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)

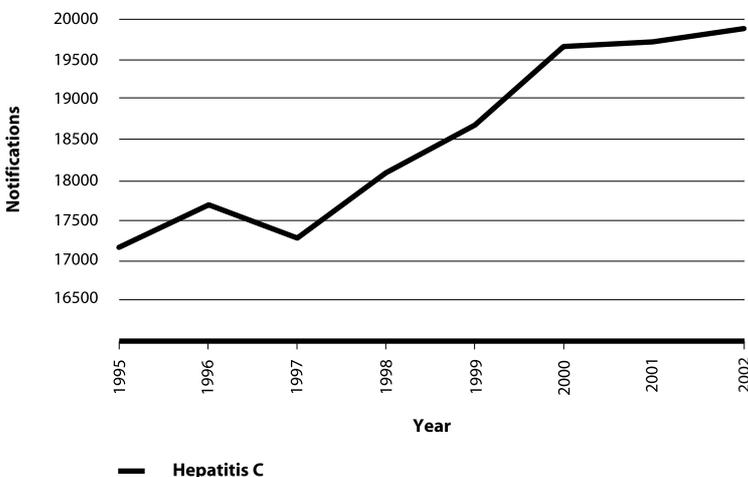
For many years it had been known that there were some cases of hepatitis in people who had received blood transfusion that were not due to HBV nor to hepatitis A, the form of viral hepatitis transmitted through contaminated food and water. In 1989 a new virus, named hepatitis C (HCV), was detected and 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



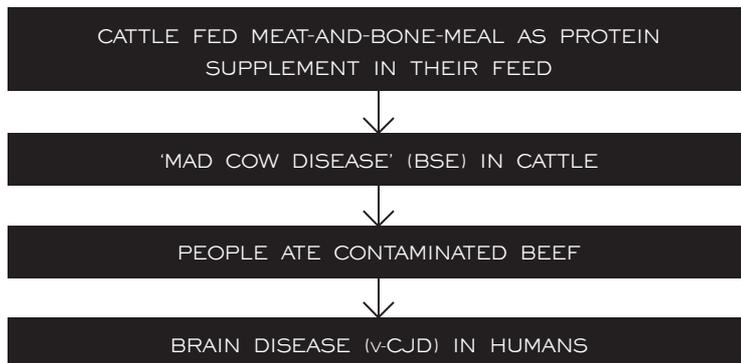
## THREATS FROM BSE AND v-CJD

'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.

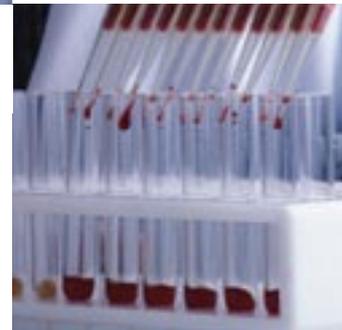
In 2001, a series of letters laced with finely milled anthrax spores infected 22 people and caused 5 deaths in the USA. Several people were infected indirectly from anthrax spores that escaped from letters into mail-rooms and other buildings. The resultant mass anxiety caused major social disruption: 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.*

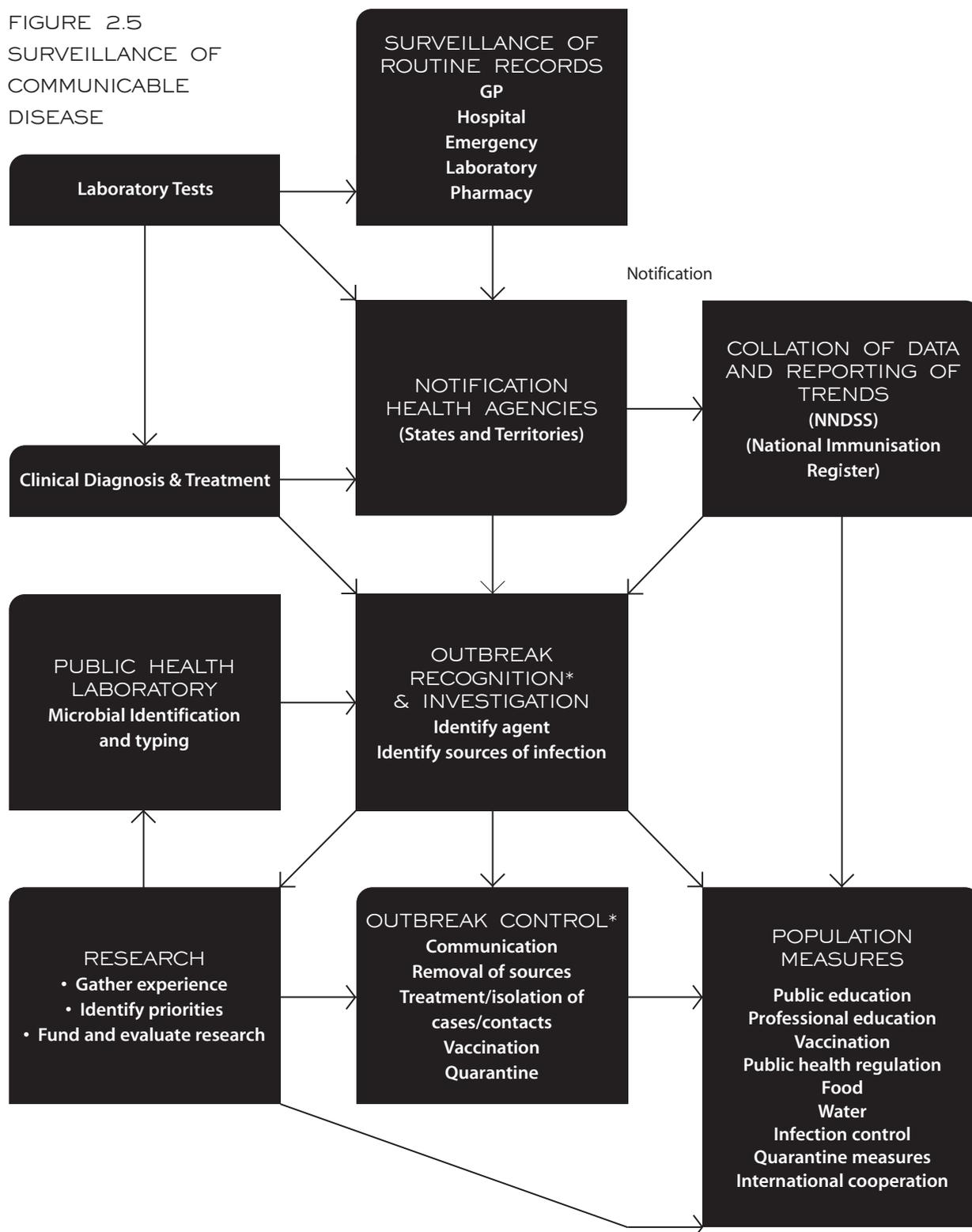
*This outbreak could have been much larger if the milk had been more widely consumed.*

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

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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.



# CHAPTER THREE: EVERYBODY'S BUSINESS

All of us have a responsibility to prevent the spread of communicable diseases. The behaviours we choose as individuals can affect transmission of many infections. For example, rejection of vaccination can threaten the life of infants exposed to serious diseases such as whooping cough. Sharing of syringes by intravenous drug users will spread blood-borne disease such as hepatitis C virus or HIV. A simple breakdown in hygiene can lead to a large outbreak of food borne disease.

Why do we continue to behave in ways that spread disease? The reasons are complex, often personal, and may involve a trade-off between an infection risk and a countervailing benefit. In our daily lives we are exposed to multiple risks. In deciding which risks to accept, we theoretically balance each risk against the inconvenience and the loss of enjoyment necessary to avoid it. As individuals we all need to be 'in the know', gathering information from experts, media and government about disease risks and control measures. As a community we need to view not only the impact of our choices on ourselves, but also the impact on the rest of the community.

## IDENTIFYING RISK

Communicable disease risks depend on the ways that different microbes are transmitted. The risk of sexually transmitted disease following unprotected sex is obvious. Other risks may be less obvious.

Contaminated food or water leads to gastroenteritis. But how do we tell if food is contaminated? Raw meat and sea food are often contaminated during processing. Risky foods are those that have been poorly refrigerated, lack preservatives, are prepared in unhygienic conditions or kept warm, but not hot, for long periods of time. These conditions enable microbes to multiply<sup>30</sup>, and would be present in many food stalls in developing countries. Most travellers would already avoid such stalls, just as they would recognise the need to sterilise their drinking water in areas where diarrhoeal diseases are endemic or the water is untreated. Similar risks also apply in developed countries like Australia, albeit less often. Each time we eat food we implicitly balance the risk of infection against our need to eat and enjoy food. Risks can be greater for some individuals than for others. For example, soft cheeses and pâté sometimes contain the organism *Listeria*. In most people this organism causes no harm, but in pregnant women and immuno-compromised people it can cause serious infection<sup>9</sup>.

Another risk comes from any break in the skin that allows infection to be introduced. For example, a puncture from a rose-thorn can lead to deadly tetanus in an un-immunised person, or to a serious bacterial infection requiring antibiotic treatment. Mosquito bites through the skin can introduce malaria or viruses; re-used needles and syringes or tattooing equipment can spread hepatitis B or C viruses or HIV. Intravenous lines in hospitals, improperly used, can allow dangerous bacteria to get into the blood stream. The skin provides excellent protection against infection but this protection is lost if the skin is pierced, abraded or burnt.



How else can organisms make their way into the body? The mucous membranes of the body are the moist areas: the lips, genital tract and conjunctivae that cover the eye. Such surfaces can allow many organisms to invade; they do not provide the same protection as intact skin. Unprotected sexual activity is well recognised as risky, but the conjunctiva of the eye is also vulnerable to organisms such as the common cold virus or more serious infections such as SARS.

Respiratory microbes enter the body through the mouth or eye, or by being inhaled. When someone with an infection coughs or sneezes, about two-thirds of the infective material will settle on surfaces or people nearby. Hands may become contaminated directly, or through contact of contaminated surfaces, and transfer infective material to the eye or mouth. Through evaporation from small droplets, about one-third of the infective particles from a cough or sneeze will become permanently airborne. Others in the room, or those breathing re-circulated air, are then at risk of infection if the particles are breathed into the lungs.

## REDUCING RISK

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### SAFER FOOD AND WATER

Food-borne disease is prevented by avoiding contamination of food with faecal or other infected material and by preventing the multiplication of microbes<sup>30</sup>. Food needs protection 'from paddock to plate' because contamination potentially starts on the farm and can occur at any step along the path to the mouth. Improvements in harvesting, slaughtering and handling procedures now enhance the cleanliness of farm products, while appropriate packaging and refrigeration reduce contamination during transport and storage. We need to pay constant attention to prevent contamination from fingers, flies, vermin, and other food and utensils. Cooking with complete penetration of heat for enough time will kill most microbes. However, there is still a possibility of food poisoning from foods contaminated after cooking or from preformed toxins that are not inactivated by cooking.

Over the centuries, food has been preserved through drying, or adding salt, sugar or acid to limit spoilage and multiplication of microbes. In more recent times, refrigeration has been effective in limiting bacterial multiplication during food storage. But even in commercial refrigerators, cold-tolerant pathogens such as *Listeria*, a hazard for pregnant women, can grow below 5°C.



The most widely accepted control system for food-borne disease is based on determining sites in the food chain that are a potential site for contamination. Experts identify all risks in the processing chain (Hazard Analysis- HA) and locate places (Critical Control Points - CCP) at which simple checks or tests (eg of temperature) can monitor any need for necessary corrections. The HACCP system<sup>71</sup> focuses attention on preventive measures that are easy to audit rather than on a mass of regulations. It aims to assure



quality at all times even when the inspector is absent. Businesses are upgrading their food safety management systems, using 'tools' to implement food safety program with minimum cost and time. Developmental projects involve commercial food services, children's services, hospitals, nursing homes, school canteens, aboriginal community stores and seafood providers.

Australian drinking water guidelines set high standards<sup>72</sup>. The water treatment required depends on the quality of the source water. Uncontaminated ground water from an area free from human or agricultural waste needs less treatment than water from a source where contamination is possible (see Box 3.1<sup>73</sup>).

*Box 3.1 Will further water treatment lead to better health? - An innovative approach*

*Melbourne has a highly protected water source. Its drinking water is drawn from virgin forest catchments in the Yarra Ranges, free from agriculture or human habitation. Additional protection is afforded by long storage times in large reservoirs before the water is chlorinated and distributed in a secure and closed distribution system. Melbourne is one of only about six major cities worldwide to have an unfiltered surface water supply. There has been increasing pressure for the city to install filtration at a cost of about A\$500 million.*

*To resolve whether this expenditure was necessary, a large randomised clinical trial – The Water Quality Study – tested whether sterilisation of drinking water would provide any reduction in gastrointestinal disease. Six hundred families comprising 2,800 individuals had either a real or a fake drinking water treatment unit installed in their kitchen. Over an 18-month period, families recorded the number of episodes of gastrointestinal disease. There was no difference between the two groups, indicating that further treatment of Melbourne's drinking water to remove organisms would not provide any health benefit to its public. Accordingly, no filtration plant is planned for Melbourne. This study was one of the first of its type in the world.*



**Margaret Burgess** - Director of the National Centre for Immunisation Research and Surveillance in Sydney - and a highly respected researcher and advisor on vaccination issues.

## VACCINATION

Vaccination dates back to 1796 when Jenner first showed that cowpox vaccine could prevent smallpox<sup>14 15</sup> (see Box 3.2). Vaccines for many other diseases were widely introduced in the 20<sup>th</sup> century. The first diphtheria vaccine and pertussis (whooping cough) and tetanus vaccines were introduced in the 1920s, poliomyelitis in the 1950s, and measles in the 1960s. Dramatic reductions of these serious diseases were seen in each decade following vaccination, as shown in Table 3.1.<sup>67</sup> Other childhood vaccines were introduced subsequently: hepatitis B in the 1980s and *Haemophilus influenzae b* (Hib) in the 1990s and meningococcal C vaccine from 2003.

### Box 3.2 Cowpox protects against Smallpox<sup>15</sup>

*In the 18<sup>th</sup> century it was known that dairymaids lacked facial scars from smallpox. Folklore attributed this to their prior exposure to cowpox, a much milder disease. Edward Jenner, a country doctor in Gloucestershire, wondered whether it might be possible to deliberately protect people against the deadlier smallpox by infecting them with cowpox at an earlier age. So on 14 May 1796, in a brave experiment that would be unethical by modern standards, Jenner inoculated eight-year-old James Phipps with cowpox pus from Sarah Nelves, a dairy-maid. Six weeks later, when inoculated with smallpox, James was found to be totally resistant. Edward Jenner's landmark discovery was that vaccination with material from cowpox sores (now known to contain vaccinia virus) would induce cross-immunity and protect against subsequent disease from smallpox, caused by a related but devastating virus. Later, Pasteur and others showed that prior exposure to weakened viruses such as rabies or to inactivated bacteria such as anthrax could also induce immunity to the disease itself.*

## The herd protects the individual

Vaccination is successful not only because it protects the individuals who are vaccinated, but because disease transmission ceases when most in the 'herd' are immune<sup>68</sup>. For example, following recovery from an infection such as rubella, or following immunisation, individuals acquire long - lasting protection against subsequent infection. A rubella epidemic will end when there are so few 'susceptibles' left in the population that each case infects, on average, less than one other person. Therefore in most populations, rubella cannot spread if more than about 87% of people are immune because of prior infection or immunisation<sup>69</sup>. Even the 13% of non-immunised children will be protected because there is no virus circulating to expose them to disease. Furthermore, susceptible pregnant women will not then be exposed to the virus and their babies are thus protected from congenital rubella and the malformations it causes. However, if herd-immunity falls below about 87% because of a low uptake rate of immunisation, rubella will again be able to spread in the population, and non-immunised children will again be at risk. Consequently, rubella immunisation rates need to be sustained to maintain population immunity for as long as the virus survives anywhere in the world.

TABLE 3.1 DEATHS FROM DISEASES COMMONLY VACCINATED AGAINST, AUSTRALIA 1926–2000

Period	Diphtheria	Pertussis	Tetanus	Poliomyelitis	Measles	Australian Population
1926–1935	4073	2808	879	430	1102	6 600 000
1936–1945	2791	1693	655	618	822	7 200 000
1946–1955	624	429	625	1013	495	8 600 000
1956–1965	44	58	280	123	210	11 000 000
1966–1975	11	22	82	2	146	13 750 000
1976–1985	2	14	31	2	62	14 900 000
1986–1995	2	9	21	0	32	17 300 000
1996–2000	0	9	5	0	0	18 734 000

Indicates decade in which community vaccination started for the disease. Reprinted with permission<sup>67</sup>



**Gordon Ada** - attracted Peter Doherty to ANU where Doherty and Zinkernagel did the work that later won a Nobel prize in immunology. Professor Ada is himself a world leader in research and an adviser to WHO on vaccines.

Reduced immunisation coverage and reduced population immunity can lead to the re-emergence of vaccine preventable disease (see Box 3.3). 'Old' diseases such as diphtheria re-emerged in states of the former Soviet Union following the breakdown of public health infrastructure. Outbreaks of whooping cough, and more recently measles, have occurred in the UK when the uptake of vaccines fell as a result of unjustified alarms<sup>68 70</sup> linking neurological damage and childhood autism to vaccination.

*Box 3.3 Case studies - spread of vaccine preventable diseases in poorly vaccinated groups*

**Measles in the Netherlands:**

*In 1999, a cluster of five cases of measles was reported among the 390 students attending a religious elementary school. Persons belonging to this denomination routinely refuse vaccination. Municipal health services investigated and found 160 suspected measles cases among children attending the school. Eight months later 2,961 measles cases, including three measles-related deaths, had been reported to the national registry, as a result of a national epidemic triggered by the school outbreak.*

**Diphtheria in the newly independent states of the of the former Soviet Union:**

*Between 1990 and 1997, local production of diphtheria vaccines ceased and children were not vaccinated. This resulted in a major epidemic with over 150,000 cases of diphtheria and more than 5000 deaths. The epidemic continued until alternative arrangements for vaccine supply were made.*

*There were also many cases among adults, whose immunity had faded following vaccination in infancy, raising the question of whether booster doses should be given every 10 years.*

## PREVENTING MOSQUITO BITES

The most effective measures to reduce diseases spread by mosquitoes are to reduce mosquito numbers and to change people's behaviour. Mosquito reduction programs can minimise threats in urban centres while surveillance can provide early warning of infectious agents or of a threatening build-up of mosquitoes. Education campaigns encourage people to destroy sites where water can pool and mosquitoes can breed, (eg in old tyres), to avoid risky outdoor activities (such as camping near swamps, fishing or hunting at dusk or dawn) and to protect themselves from bites by wearing long, loose fitting clothing and by using topical insect repellents. Australian surveillance programs provide early warnings of virus transmission and mosquito activity through blood tests on sentinel flocks of chickens, strategically placed, as 'sitting ducks' in rural areas.

## PRACTISE SAFE SEX

All sexually transmitted infections (STIs) are potentially controllable through 'safe sex' practices, case-finding, treatment, or vaccination<sup>53</sup>. The most effective control strategy is to encourage individuals to protect themselves and others (see Box 3.4).

STIs are transmitted by people who have, or have had, multiple partners. If an individual ignores safe sex messages, there is a risk of sexually transmitted infection (STI), not only for that person, but also for future partners and future partners of partners. Over the past few years there is evidence for a decline in the impact of safe sex messages in Australia<sup>54 56</sup>. It is timely to explore how messages about sexually transmitted infections, sexual risk and responsibility, and safe sexual practice can be delivered more effectively, particularly to younger

persons who may be ill-informed, or more likely to take risks. Messages about safe sex and social responsibility need to be complemented by research to evaluate the effectiveness of such messages in modifying behaviour.

### Box 3.4 Sex is safer if .....

- *blood, semen or vaginal fluids from a sexual partner do not enter another's body,*
- *condoms are always used correctly or sex is with partners known not to have a sexually transmitted infection,*
- *a partner has not had lots of other partners.*



## USE STERILE EQUIPMENT IF INJECTING

In Australia today, over 90 percent of hepatitis C infections are associated with injecting drug use. Hepatitis C transmission would virtually cease if injecting equipment is never shared between drug users<sup>58</sup>.

An important and effective public health measure has been Australia's Needle and Syringe Program<sup>74 75</sup>.

Providing free and sterile needles and syringes reduces the risk that people will re-use injecting equipment and spread of the viruses that may be contained within.

### Box 3.5 Prevention

*Needle and syringe programs provide new sterile syringes and needles to prevent spread of infections through reuse of contaminated equipment and:*

- *encourage clients to dispose of used equipment safely,*
- *collect used needles and syringes,*
- *refer drug users to treatment.*



## QUESTION THE NEED FOR AN ANTIBIOTIC

Health professionals and the public now recognise the risks we face from antibiotic resistant bacteria.

The central message is that if antibiotics are 'demanded' by patients or prescribed by doctors when not really needed, the risks of generating and spreading antibiotic resistant bacteria are greatly increased.

Australia is one of the highest users of antibiotics per person in the Western world: about 24 million prescriptions annually. There are more antibiotic prescriptions written per person in Australia than in the USA. Perhaps half of Australian prescriptions are unnecessary<sup>21</sup>. Recommendations for doctors about antibiotics have tended to focus on 'which antibiotic' rather than on whether to use an antibiotic at all. Use of antibiotics in animals poses additional risks.

### Box 3.6 Antivirals

*In recent years new medications, called antivirals, have been developed which can treat serious virus infections such as influenza or HIV. These also need to be used responsibly to avoid emergence of resistance in the relevant viruses.*

However, all is not lost with effective antibiotics. Animal uses of antibiotics are now subject to regulation. Prescribers and consumers are becoming more circumspect about antibiotic use. New 'rapid tests' to discriminate bacterial infections from viral infections, which do not need antibiotics, will support more rational prescribing. As antibiotic use is restricted to the more serious bacterial infections, there will be less selective advantage for resistant bacteria. Indeed, in an antibiotic free environment, bacteria with out resistance genes have a slight competitive advantage, and the frequency of resistant strains will fall, as has already been described in Denmark<sup>76</sup>. This will prolong the useful life of existing antibiotics. Furthermore, new antibiotics will be discovered, and novel antimicrobial substances will be developed, using new genetic information, to block resistance mechanisms in the bacterial cell. Some older, discarded antibiotics have even been shown to be effective against new infections.<sup>77</sup>

Patients, the media, doctors, nurses and pharmacists can all help to ensure that antibiotics are used less frequently and only when really needed. The 'Common colds need common sense' campaign, conducted by the National Prescribing Service and the Australian Consumers' Association, is one successful initiative. In the longer term such initiatives will help



to reduce the frequency of bacterial strains resistant to antimicrobials. Antibiotics don't cure viral infections such as colds or flu. New drugs for viral infections need to be used carefully (see Box 3.6).

## ENGAGE INFECTION CONTROL

Infection control is not a new concept (see Box 3.7 and 3.8). Hygienic behaviours have long been recognised and have been taught through generations. The notion of 'public hygiene' seeks to prevent the spread of organisms from an infected person or source to someone who is uninfected. As described in Chapter One, when people are closer together or in crowded living conditions, infection can spread readily from person to person through inadvertent contamination and transmission of faecal material or respiratory secretions. Infection control guidelines aim to break the chains of microbial transmission through hand-washing and safe disposal of waste and secretions. Gloves, masks and gowns and isolation may be required in high-risk situations.

Special guidelines are available for people who work in child care<sup>26</sup> and aged care to help them reduce the transmission of disease. Prevention not only reduces immediate illness,



it can also reduce the need for antibiotics in situations where they have come to be frequently used. This in turn can be expected to reduce the prevalence of antibiotic resistant organisms. Thus the prevention of cross-infection in group care can help to ensure that antibiotics will still be effective in treating serious infections.

### **Box 3.7 Underlying Principle of Infection Control**

*Break the chain of transmission from one infected person to the next.*

### **Box 3.8 Echoes from the past**

*'There is nothing to prevent as perfect a condition of sanitation in the Australian colonies as obtains in England. We have not overcrowding and poverty to contend with, our climate is one of the most healthful in the world, and we have ample means at our disposal. What we require is (1) special legislation; (2) organization and co-ordination of authority; (3) the sympathy and assistance of the public, who, at the present time, display an apathy in all matters of public hygiene.'*

*Intercolonial Medical Congress of Australasia  
Melbourne 1888*

Most recently, the global outbreak of SARS (Chapter 2) has reawakened our attention to the importance of infection control measures and guidelines (see Box 3.9)<sup>78</sup>.

#### *Box 3.9 Infection Control for SARS – A Case Study*

*SARS spread quickly from country to country in the early days of the epidemic when sick people were still allowed to travel by air. Subsequently, airlines and SARS-affected countries have restricted travel for people with symptoms of SARS, and for those who might be incubating the disease. This has helped to protect countries such as Australia.*

*At the Australian border, travellers have been alerted to SARS, and to the importance of seeking early attention should symptoms develop after arrival. Incoming passengers with symptoms are assessed and referred for expert management as required.*

*Persons under investigation for SARS have been managed in isolation, with barrier nursing (gloves, gowns, masks and goggles, no touch techniques and safe waste disposal) until the diagnosis is excluded or the patient recovers. The overseas experience has been that without stringent infection control precautions, SARS-affected patients are very infectious for those in close contact with them, and particularly for health care workers in emergency departments or wards who have not taken adequate precautions.*

*SARS only appears to be spread from people who are ill with the disease. However, as an extra precaution, contacts of known SARS cases, even if free of symptoms, have been excluded from hospitals and health care facilities for 10 days. Persons returning from SARS-affected countries need to be excluded from work or school only if they develop symptoms during the notional incubation period.*



## PREVENT 'HOSPITAL ACQUIRED INFECTION'

The risks of acquiring an infection in hospital should not cause undue fear, as they do not outweigh the benefit of hospital treatment<sup>35</sup>. Nevertheless, patients can be more pro-active about their management in the health system, and be aware of what should be done to protect them from infection in hospital. For example, they should feel able to ask the doctor or nurse to wash their hands before contact and health care professionals should expect to be asked to do so. Unfortunately, infections acquired in hospital are more likely to be due to an organism that is resistant to antibiotics than an infection acquired in the community<sup>21</sup> (see Box 3.10). Hospital-acquired infections are thus more difficult to treat.

Health-care associated infections are of major concern because of the impact of deaths and disability on individual patients, families, and health staff, and the financial burden to the community resulting from longer patients stays and increased treatment costs. It is estimated that surgical site infections could cost as much as \$286 million per year, and bloodstream infections as much as \$686 million per year. The Australian Council for Safety and Quality in Health Care has made recommendations to strengthen surveillance and reporting of health-care associated infections, to strengthen infection control guidelines and incentives for compliance, and to monitor improvements over time<sup>35 79</sup>.

The complexity and time pressures in the modern health care system can make it difficult to prevent hospital-acquired infections, and delay detection and response. New infection control procedures, if implemented piece-meal, run the risk of overloading a system that is already highly stressed. Accordingly, there is a new emphasis on a system-based approach to infection control, using information technology to support training, communication, surveillance and follow-up<sup>80</sup>. Standardised guidelines for surveillance are being introduced<sup>81</sup>.

### *Box 3.10 People in hospitals are at risk of infection*

*Patients are more likely to acquire infection if:*

- *intact skin is broken by intravenous lines wounds or burns,*
- *bowel surgery releases bacteria into usually sterile sites,*
- *urinary catheters are placed into the bladder,*
- *nearby patients have serious infections or are on antibiotics.*

*Patients are more susceptible to infection if they are:*

- *debilitated through illness,*
- *in an older age group,*
- *immuno-suppressed because of HIV or drugs that suppress the immune system.*

*An infection is more likely to be due to an antibiotic resistant bacterium if the patient himself, or any nearby patient, has already been treated with antibiotics.*

*Health staff are also at risk of infection. Stabs with used needles can transmit HIV or HCV. Close contact can spread other infections, including SARS.*

## INVOLVED COMMUNITIES

### CONSUMER PARTICIPATION IN DECISION MAKING

Communicable disease controls have previously relied heavily on public health legislation to ensure safe food and water, waste disposal and human and animal quarantine. Nowadays, the community is better informed and able to be more directly involved in decision-making about health, with strong support from health promotion and consumer movements, governments and public health professionals. An informed public will be better able to protect itself from infection, and to participate in public discussion and decision-making. Wider participation will help to broker prevention and control programs that are technically sound, cost-effective, and most acceptable to the public and affected groups.

#### Box 3.11 By and With

*'Health promotion is carried out by and with people, not on or to people. It improves both the ability of individuals to take action, and the capacity of groups, organisations or communities to influence the determinants of health.'*

*The Jakarta Declaration on Health Promotion in the 21<sup>st</sup> Century (WHO, 1997)*

Australia's rapid and effective response to the AIDS epidemic was built on outstanding political and scientific leadership, strong community support, and professional strengths in epidemiology, virology, immunology, clinical medicine, and public health. Australia's partnership approach to controlling HIV depended on community education, community action and relevant social research. Early in the epidemic, gay groups recognised the risk, and how to prevent it, and helped to drive the education and harm minimisation programs that were supported by government.



#### Box 3.12

##### *HIV/AIDS Control in Australia-Determinants of Success*

*Awareness and leadership from the most affected community (including gay men and people living with HIV/AIDS).*

*Political commitment from governments:*

- *to provide resources for prevention, treatment and care,*
- *to deliver education programs through peer educators,*
- *to educate the wider community,*
- *to protect privacy and avoid stigmatisation.*

*Expert scientific, social, medical and public health input into:*

- *strategies for prevention and treatment,*
- *monitoring of the epidemic,*
- *research and development.*

*Acceptance of alternative lifestyles in the media and the wider community and avoidance of stigmatisation.*

*Needle and syringe exchange programs*

We have also learnt valuable lessons about community participation to improve health for Indigenous Australians. Where the local community is fully involved, immunisation has had excellent take-up rates, and interventions for treatment and prevention of diseases such as scabies, impetigo and rheumatic fever have been sustained<sup>82</sup>. Indigenous communities thus benefit from multi-disciplinary teams to deliver health care and health promotion messages that are sensible, locally relevant and medically appropriate. With improved nutrition, safe water, sanitation and hygiene facilities, a healthy lifestyle, and good medical care, rates of communicable and chronic diseases amongst Indigenous Australians will fall towards those of other Australians.

## MAINTAINING TRUST IN THE WIDER COMMUNITY

Without trust and openness, it is difficult to maintain confidence in public health measures. Interventions to control the spread of disease are inevitably based on imperfect knowledge, even though it is the best information available at the time. The public recognises that

health decisions are difficult, but people may not respect the chosen path if they are not given all of the information. Open decision making is crucial and experts and government agencies at times must be prepared to acknowledge uncertainty. This is perhaps the major lesson to come out of the UK epidemics of BSE and v-CJD.

Effective media communication is fundamental to control of communicable diseases. If the media know the background to public health issues and decisions, the community will be better informed and more able to understand interventions and policies. However, as the media also need to 'sell' a story, some will report with unjustifiable sensationalism. Sensation can have unintended consequences which harm the community interest, as exemplified by the 'copy-cat' hoaxes that followed media reports of anthrax attacks in the USA. Furthermore, fear can spread rapidly if the risks and control measures for communicable disease are presented in the media without adequate explanation. A balanced and informed media can ameliorate fear and support the effectiveness of disease control measures through enhanced community understanding.

Unfortunately, even comments from health experts can have unintended consequences. Some experts, in a competition to be heard, can overstate risks, or exaggerate new research findings as a strategy to promote funding. Sometimes, their highly specialised views can promote an unbalanced perspective of health priorities, and unnecessarily fuel public alarm. It is the proper role of an informed media to explore the claims of experts, and to report on them with an eye on the overall community interest.



## BALANCING COMMUNITY AND INDIVIDUAL INTERESTS

Traditional measures for communicable disease control, such as quarantine and isolation, show how individual freedom has sometimes been constrained in the interests of others in the wider community (Table 3.2). How far should health authorities be able to go to prevent transmission of infection? For, example, should

health authorities be able to require that a person potentially incubating SARS be placed under surveillance for the duration of the incubation period? Once someone develops symptoms of a disease such as SARS, should they be compelled to accept care as determined by health authorities? What is the responsibility of those who know they are infected to not infect others?

In modern democratic societies, we accept the libertarian principle that competent people, who are sufficiently informed, should be

free to take risks or lead lifestyles that might increase the probability of them becoming ill or even dying early. The sentiment of 19<sup>th</sup> century British philosopher John Stuart Mill<sup>83</sup> is echoed in contemporary thinking about public health policy: 'The only purpose for which power can be rightfully exercised over any member of a civilised community, against his will, is to prevent harm to others.'

TABLE 3.2 INDIVIDUAL AND COMMUNITY INTERESTS IN COMMUNICABLE DISEASE CONTROL

Individual Choice	Community Interest
To be free to refuse childhood immunisation.	Unless the large majority of children are immunised, vaccine preventable diseases will continue to spread.
To be able to travel freely.	If people carrying exotic diseases are not quarantined or treated the diseases could be introduced.
To refuse isolation if infected with an exotic disease such as drug resistant TB or SARS.	If infected patients are not isolated, many more people will be secondarily infected.
To behave in a way that might lead to infection, or to the infection of others.	Infected individuals may place others at risk of infection.
To maintain privacy about infection status.	If a person not known to be infected behaves irresponsibly, the infection will be more widely spread.
To maintain privacy about past contacts.	If not traced, contacts may miss out on diagnosis and treatment, and themselves inadvertently infect others.
To refuse diagnosis or treatment.	Untreated infections are more likely to spread to others.
To accept responsibility for personal decisions and behaviours.	The community will be called upon to share the risk, and bear costs of prevention and treatment.

Individuals sometimes make personal choices that increase their risk of infection; they may fail to take precautions or refuse vaccination. However, if such a choice also places other persons at involuntary risk, society needs to consider whether the freedom of the risk-taker should be constrained. For example for a person who knows he or she has HIV, should there be sanctions against unprotected sex with new partners? Even in the absence of risk to another person, if the financial costs of voluntary risk-taking are to be borne by society, then society could also make a claim to constrain the freedom to take risks.

In previous generations, the choice between individual and community interests, such as in Table 3.2, were resolved through legislation or regulation. In our modern democracy, we prefer persuasion to coercion. Essentially, we explain the risks, and we ask risk-takers to act responsibly and take better care of others as well as themselves. However, if individuals cannot be persuaded, there are public health legal powers, in most jurisdictions, that can be used as a last resort.

## CONCLUSION

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Communicable diseases affect us all. The choices we make day-to-day influence our risk of acquiring an infection and the chance of spreading this infection to others. As individuals we are responsible for our loved ones and ourselves, but we are also responsible to our wider community. If we understand how diseases spread and act responsibly, with measures as simple as hand-washing, safe sex and home hygiene, we will be playing our part to minimise communicable diseases in the uncertain world of the future.

To keep Australia healthy, our best strategy is to ensure that the community and media are well informed, with opportunity for public discussion, that our scientists and health professionals continue to be well trained, and that governments continue to provide leadership and accept overall responsibility. Such plans really are everybody's business.



# CHAPTER FOUR: LOOKING BACK LOOKING FORWARD

## WHERE ARE WE NOW?

### GLOBAL BURDEN OF COMMUNICABLE DISEASE

In the 21<sup>st</sup> century, we live in an unequal world where social disadvantage still leads to endemic infections for many people. Communicable diseases represent over 40% of the global burden of disease, although most of this is borne by developing countries<sup>41</sup>. The World Health Organization (WHO) works with limited resources to control diseases of poverty such as tuberculosis and malaria, to support childhood vaccination, and to respond to global emergencies such as HIV and SARS.



#### Box 4.1 An Unequal World

*Cross-infection thrives in conditions of overcrowding and poor hygiene, and when health services are less developed. Consequently, infectious diseases have a disproportionate impact in developing countries, and amongst Indigenous and other disadvantaged groups within developed countries. For example, treatable infectious diseases such as otitis media, bronchitis, pneumonia, diarrhoea, and streptococcal skin-sores are still frequent in some Aboriginal & Torres Strait Islander communities. Such conditions contribute to hearing and educational impairments and malnutrition in childhood, and to lung disease, kidney disease, hypertension, heart disease, and to premature mortality in later life.*

## HOW IS AUSTRALIA SITUATED?

In our lucky country, most Australians are at lower risk of infectious disease<sup>40</sup>. In developed societies like ours, individuals and families have easier access to knowledge, clean water and food, housing, sanitation and other facilities. Australians are thus better able to inform themselves about public health measures and to protect themselves by breaking chains of microbial transmission involving faecal contamination, respiratory secretions, body contact and body piercing. Basic prevention is straightforward: hand-washing, condom use, personal hygiene and careful preparation and storage of food. Vaccination in accordance with the recommended Australian Schedule prevents many diseases of childhood and greatly reduces the impact of influenza and other diseases in later life<sup>70</sup>.

Australia's public health preparedness has hitherto kept most diseases at bay, but history has taught us that new threats will continue to emerge.

## LEARNING FROM THE PAST AND THE PRESENT

To help prepare for future disease threats, we can learn from the past and the present. We need to understand how human behaviour can influence disease transmission, the evolution of causal microbes, and the emergence of new diseases. We have many examples from the remote and recent past. We know that population movement and mixing at times of war, famine and social unrest are major determinants of epidemics. Indeed, with modern transport, we live in a much 'smaller' world.

### *Box 4.2 A Smaller World*

*If each of us is only "six handshakes" away from any other person on the planet, it is little wonder that diseases can spread around the world so quickly.*

We know that HIV has been spread around the world by people using rapid transport, by men working away from their families and by changes in sexual activity. We know that blood-borne diseases have been driven by dirty needles and by the epidemic of intravenous drug-use. We know that BSE and v-CJD arose because of changes in cattle feeding practices. We know that de-deforestation and other human impacts on the global environment have affected the risk of malaria and other vector-borne communicable diseases. We know that the imprudent use of antibiotics has contributed to emergence of pathogens that are increasingly resistant to treatment. We also know that medical advances such as transplant surgery, blood transfusion, intensive care, steroids, and anti-cancer treatments have been of great benefit to individual patients. Yet we also know that because of these advances, more people are vulnerable to infections which spread so easily in a busy hospital environment.



**Robert Koch** - In the 1880's he discovered the TB microbe and laid many foundations for microbiology. His main rival was Louis Pasteur. (see Appendix 2). Photo with permission from The Wellcome Trust

## REALISING THE FUTURE

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### GLOBAL KNOWLEDGE - EXPERTS AND THE MEDIA

In a knowledge-rich world, served by the Internet, we have almost instant access to health information. Our major challenge is to interpret and evaluate and to transfer current knowledge into improved communicable disease control and practice for the public good.

In years past, when we understood less, but when the ravages of communicable disease were there for everyone to see, the community was more prepared to act on expert advice. Today, in an increasingly complex world, although the experts have more knowledge to communicate, their knowledge can be fragmented and discipline-based. Furthermore, experts must often compete to be heard. We may need to synthesise differing views, to integrate clinical, public health, social and biomedical knowledge and to create an interdisciplinary perspective to better serve the public interest.

With instant global communication, the media are also well informed about health matters, with an increasing interest in communicable diseases. The media role is to inform the public, promote discussion, and test the rationale for expert opinion and government policy.

### RESEARCH TO GROW NEW KNOWLEDGE

New knowledge comes from research, which is sometimes epoch-making. We have all heard of the DNA double-helix, first described by Watson and Crick in 1953 (see Appendix 2). Knowledge of DNA has had far-reaching implications, spawning the sciences of molecular biology and molecular genetics and providing us with the means to understand the inner workings of all microbes and living things.

Most research is incremental, building on existing knowledge to find useful advances. Some research findings depend on serendipity, as in the discovery of penicillin by Alexander Fleming in 1928, and the discovery of *Helicobacter pylori* as a cause of peptic ulcer by Barry Marshall in Perth in 1980. Yet as Louis Pasteur said so many years ago: "Chance favours the prepared mind".

It is not yet widely understood that recent research has further blurred the edge between communicable and non-communicable disease. Many more diseases are now known to originate from infection. Certain microbes have now been shown to cause infertility, some pre-term births and birth defects, and some cancers, as well as peptic ulcers. Such new knowledge provides new opportunities for prevention or treatment (see Table 4.1).



TABLE 4.1 CONDITIONS NOT PREVIOUSLY REGARDED AS COMMUNICABLE

Condition	Responsible microbe	Status	Prevention	Treatment
Infertility	Gonococcus Chlamydia	Late complication of acute infection	Safe sex Safe sex	Antibiotics for acute infection
Preterm birth	Changes in vaginal flora (bacterial vaginosis)	Strong circumstantial evidence	Antibiotic treatment	
Birth defects	Rubella virus Cytomegalovirus (CMV)	Complication of maternal infection	Rubella vaccine No CMV vaccine	
Cervical cancer	Papillomavirus	5-40 years after acute infection	Safe sex New vaccine under trial	
Liver cancer	Hepatitis B virus Hepatitis C virus (HCV)	10-40 years after acute infection	Hepatitis B vaccine No HCV vaccine	Treat HCV infection with interferon & ribavirin
Peptic ulcer Gastric cancer	Helicobacter	Complication of stomach infection	Good hygiene Trial vaccine	Antibiotic treatment

### Australian Research in Communicable Diseases

Australia can be proud of its communicable disease researchers (see Appendix 3). We remember Mac Burnet as a world leader in virology and a Nobel Prize-winner in immunology. Frank Fenner was honoured as Australian Scientist of the Year for 2002 for his work on myxomatosis virus (helping to rid Australia of the rabbit plagues seen in the 1940s) and also for his work

on the global eradication of smallpox. Peter Doherty, Australia's only living Nobel Prize-winner, was recognised for work on the T-cell immune response to viruses that now underpins new vaccine strategies. Leaders such as Burnet, Fenner, Ada, Nossal and Doherty also established the intellectual tradition that has put later generations of Australians at the forefront of virological, immunological, vaccine and public health research.



Australian biological research is still very healthy, supported by government funding through the Australian Research Council (ARC), CSIRO, the National Health and Medical Research Council (NHMRC), and other sources. Communicable disease research has been highly competitive both locally and internationally. For example, an Australian HIV vaccine consortium, initially funded through Health and Ageing and NHMRC, has recently won additional research and development support from the US National Institutes of Health as well as from the biotechnology industry. A Biosecurity CRC (Cooperative Research Centre for Emerging Infectious Diseases) has recently been established with support from Government, universities, CSIRO, health and agricultural agencies and industry.

NHMRC<sup>36</sup> and other agencies will continue to fund communicable disease research on a competitive basis, and consider urgent proposals for emerging diseases. For example, in the SARS crisis, NHMRC provided emergency funding to help Australian public health laboratories to develop and validate the tests needed to detect the SARS coronavirus.

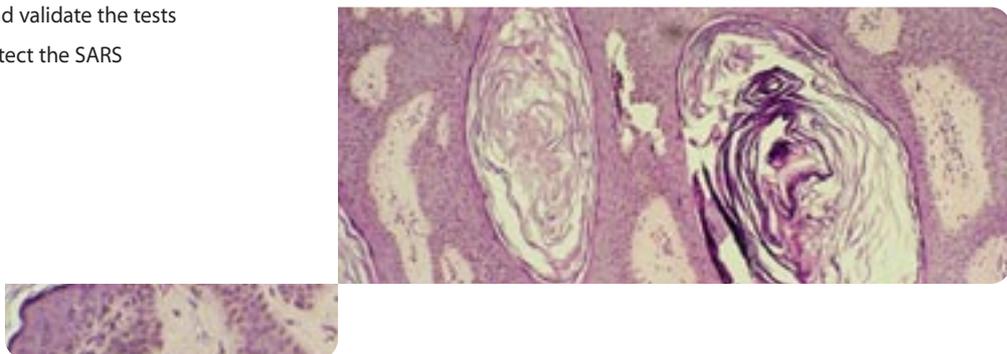
The Australian public can have every confidence that its communicable disease researchers will be able to respond to any future emergencies.

### TECHNOLOGY - NEW UNDERSTANDING AND NEW TOOLS

Future research and development will yield medical and public health innovations to support improvements in disease control. Biomedical science is providing new vaccines and other molecular tools for the prevention, diagnosis and treatment of communicable disease. New insights are flowing from reading the DNA or RNA sequences of microbial genes, and from the knowledge this gives about the protein antigens and enzymes that help the microbe to invade. New techniques can even 'knock out' the particular genes that affect microbial pathogenicity to produce harmless strains as potential vaccine candidates.

Gene-based approaches to antimicrobial discovery are now concentrating on understanding more about the organism, its genetic material and its chemical pathways rather than simply screening thousands of compounds for their ability to kill microbes. Useful new agents for treatment may have effects on RNA or DNA or the pathways for making cell constituents. New studies of bacterial communication via small signal molecules known as 'pheromones' also hold promise. If scientists can understand the natural signals that trigger microbial multiplication and virulence, they may be able to provide artificial signals that will permanently switch off the growth of pathogens, and provide new tools for disease control.

The possibilities for disease control in the future, based on knowledge both new and old, seem endless and exciting.



#### Box 4.3 Rediscovering ecological approaches

*For centuries, we may have been inadvertently practising ecological approaches to disease control. For example, by isolating influenza patients with the most severe symptoms, and preventing them from infecting others, we may have given a selective advantage to influenza variants causing milder symptoms.*

*It has long been known that the normal microbes on our skin and in our bowel can help to prevent invasion by more damaging organisms. Indeed, part of the danger from antibiotic resistant pathogens comes from the fact that antibiotic treatment can kill the 'normal flora' that would otherwise keep pathogens in check. It may seem incongruous to treat patients with bacteria, yet the live bacteria in yoghurt and probiotic capsules have been used to treat thrush and gastro intestinal disturbance after antibiotic administration. Similar ecological approaches, to re-introduce normal bacteria into the respiratory tract, are now being trialled to prevent otitis media. There is a growing area of research directed towards a better understanding of the interactions between normal flora and potential pathogens.*

## PUBLIC HEALTH AND CLINICAL SKILLS

In the SARS crisis, Australia drew on its deep expertise in public health, in clinical and laboratory diagnosis, and in treatment of communicable diseases, just as it has in other past emergencies (see also Chapter 3). The knowledge base of Australian communicable disease experts, supported by a cooperative ethos, and by linkages through governments and professional associations, underpins our capacity to detect and manage the disease problems that we already know about and to respond effectively to new diseases that may emerge in future.

Clinical and public health experts, understanding the importance of public communication, have also taken the time to provide input to this report to inform stakeholders about the complex scientific, clinical and social issues that arise in communicable disease control.

## INVOLVING THE PUBLIC

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### PUBLIC UNDERSTANDING, TRUST AND CONFIDENCE

In historical times, people trusted family and friends to protect them and provide safe food and water. In contemporary democracies, we trust governments, as well as our fellow citizens, to protect us. When we buy food we are confident that it will be safe. When eating food prepared by others, we trust the take-away or restaurant. Without such mutual trust, our society could not function.

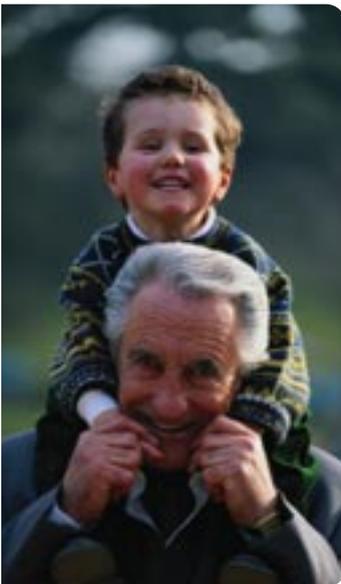
Threats from communicable disease and from bio-terrorism can affect our society in two ways. First, there is the small but real threat of harm from a disease epidemic or terrorist act. More insidiously, fear could supervene if we can no longer trust each other or no longer trust the safety of the civic institutions and services (food, water, mail etc) that we have hitherto taken for granted. Public confidence can be best supported by frank communication to improve community awareness and understanding of the issues. If public confidence breaks down in one area, as it did in the UK during the BSE crisis, it can have flow-on effects in others, as with the loss of confidence in measles, mumps, rubella (MMR) vaccination by the UK public.

Community support for communicable diseases cannot always be taken for granted. Only the older generations remember the epidemics and infections of the past and there may be limited public understanding of the measures, often invisible, needed for disease control. Effective prevention is rarely acknowledged, and may be missed only when it breaks down, as happened with diphtheria immunisation in post-Gorbachev Russia.

SARS has provided the latest of several wake-up calls about communicable diseases. While other diseases have emerged in recent years, none have spread as rapidly as SARS. We could not have anticipated the economic costs of SARS to global tourism and trade. During the outbreak, government leadership enhanced public

awareness and supported intersectorial involvement in disease prevention and control measures. SARS has provided a trial of our plans and preparations for microbial threats. Across all sectors we have seen increasing collaboration between agencies and professional disciplines, with stronger international linkages and strategic plans for response, research and frank communication. The public deserves no less.

A public with better understanding of communicable diseases will not only be able to take better care of itself, but also to better question, support and influence the decisions made by government and by experts. In the longer term, this will provide greater public trust and confidence.



## CONCLUSION

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This report, *'Protecting Australia against Communicable Disease: Everybody's Business'* is intended to help the Australian public to understand the challenges from infectious diseases. Until the 1980s, we might reasonably have been asked: 'Why worry? Haven't we in this country been on top of communicable diseases for decades now?' Yet HIV, BSE and variant-CJD changed all that. Furthermore, we saw the US epidemic of West Nile virus from 1999, followed by anthrax in the USA and 'white powder' scares in 2001, and the global emergence of SARS in 2003.

The underlying messages in this report are simple. Firstly, if Australians understand more about communicable diseases, they will be more able to protect themselves through hygiene, safe-sex, vaccination, and the prudent use of antibiotics. Secondly, many communicable disease problems, including SARS, BSE, variant-CJD, HIV and hospital acquired infections are the unintended consequences of changes in human society and behaviour. Thirdly, because microbial agents causing communicable disease can evolve quickly to exploit new opportunities, or to escape our interventions, we cannot predict how they will change, and we may never finally win the arms race against them. Fourthly, with global threats from terrorism, there is the possibility that microbial agents, new or old, might be spread deliberately. The risks are low, but we have already seen, following the white powder "false alarms" around the world, how fear can cause public alarm that is out of proportion to the real threat.



It is 'everyone's business' to understand the historical importance of communicable diseases for human society, and to understand how new communicable diseases can continue to emerge. Endemic communicable diseases still represent over 40% of the global burden of disease, although most of this is borne by developing countries. In past centuries, communicable diseases were a threat to the very survival of humankind. That could still be true in the 21<sup>st</sup> if there were a new pandemic such as influenza.

Unfortunately, memories of past epidemics are fading. Some parents of this generation have mistakenly come to question the value of vaccination, and there has been a sense that we in Australia do not have to be unduly concerned about infectious diseases.

Yet Australia is not invulnerable. International travel and trade expose us to epidemics from other countries. Our rapidly changing world will continue to provide opportunities for diseases such as tuberculosis or pandemic influenza to return, and for entirely new diseases to emerge. The profligate use of anti-microbial agents in many countries has led to an increase in microbes that are resistant. Many infections have become difficult to treat, and we may even be in danger of moving into a 'post-antibiotic' era.

Australia has done comparatively well – so far – in controlling communicable disease, but this is no reason for complacency. If Australia is to continue to be comparatively free from infectious diseases, there is a clear need for heightened public awareness, vigilance, preparedness and research.

Communicable diseases really are 'everybody's business', and the actions of ordinary Australians are likely to be as important as the skills of experts and the actions of governments in keeping them at bay. With its well-trained workforce, its research expertise, an informed community and good working partnerships, Australia is well placed to meet the communicable disease challenges of the future.



# GLOSSARY

Aerosols	Nebulized particles suspended in a gas or air.
Agent	As in “microbial agent” – an entity that has an effect.
Antibiotic	A substance able to destroy or interfere with the development of a microbe, typically a bacterium. An antimicrobial agent, derived from cultures of a micro-organism or produced semisynthetically; used to treat infections.
Antigen	A substance, usually a protein, that causes the formation of an antibody and reacts specifically with that antibody.
Antisepsis	Destruction of micro-organisms to prevent infection, usually by chemical means.
Antiviral agents	Prevent the growth or release of viruses.
Asepsis	1. The absence of germs. 2. Surgical asepsis, protection against infection before, during, or after surgery by the use of sterile technique.
Asymptomatic	Without symptoms.
Commensal	A microbe that lives in or on a host without causing disease.
Coronavirus	A member of a family of viruses that includes several types capable of causing acute respiratory illnesses in animals or humans. The SARS virus is a novel coronavirus, not previously described.
DNA	Deoxyribonucleic acid – the genetic material that codes the instructions to make living cells.
Ecology	The study of the interaction between living organisms and their environment.
Ectopic pregnancy	A pregnancy that occurs outside the uterus.
Endemic	Of a disease or micro-organism that tends to persist in a geographic area or population.
Epidemic	A disease that spreads rapidly through a population; a disease that recurs periodically.
Epidemiology	The study of the occurrence, distribution, and causes of disease.
Gastroenteritis	Inflammation of the stomach and intestines accompanying gastro-intestinal disorders. Symptoms are anorexia, nausea, vomiting, abdominal discomfort, and diarrhoea.
Host	An organism in which another, usually parasitic, organism is nourished and harbored. (eg humans are hosts to many commensal bacteria living on the skin, as well as to pathogens).
Incidence	The number of new cases - eg in a year.
Immunological memory	Cells of the immune system, having once responded to a specific infection or vaccination – are primed to respond quickly with a protective response if exposed again to the same or a similar infection.

Immunology	The study of how cells of the immune system, such as lymphocytes, recognise antigens and make antibodies eg to protect against infection.
Imported case	A case of disease brought in from another place or country.
MBM	Meat-and-bone meal – used as an animal food supplement.
Microbiology	The branch of biology concerned with the study of micro-organisms, including algae, bacteria, viruses, protozoa, fungi, and rickettsia.
Otitis media	Inflammation in the middle ear, commonly known as ‘middle ear infection’.
Pandemic	A (severe) disease occurring throughout the world and affecting large numbers of people.
Parasite	An organism living in or on and obtaining nourishment from another organism.
Pathogen	A microbe capable of causing a disease.
Prevalence	The number of cases of a conditions at a point of time ie includes pre-existing as well as new cases.
Protein	Produced by instructions from RNA – specific proteins may be structural or, as enzymes, facilitate chemical reactions.
RNA	Ribonucleic acid – transcribed from DNA in living cells – translates instructions into proteins. Some viruses have RNA rather than DNA genes.
Sentinel	On guard to detect an invasion (of a disease).
Spores	A temporary form assumed by some bacteria to resist heat, drying, and chemicals; diseases caused by spore-forming bacteria include anthrax, botulism, gas gangrene, and tetanus.
Sputum	Material coughed up; it contains mucus, cellular debris and some microbes.
Surveillance	To detect, watch over, supervise or observe persons with a health condition.
Vaccine	Attenuated or killed microbes (or antigens) administered to induce active immunity to infectious disease.
Vector	Something that carries or transmits a pathogen, eg mosquitos are vectors for malaria.
Viral load	Viral burden – the number of viruses (eg in a person).
Virology	The study of viruses and viral diseases.
Virulence	The capacity of a micro-organism to produce disease.
Virus	A micro-organism smaller than a bacterium that replicates only within a cell of a living plant or animal host.

# APPENDICES

## APPENDIX I VACCINES FOR DISEASE PREVENTION

Disease Agent	Source, route of infection	Disease Manifestations	Vaccine type
<b>Bacterial diseases</b>			
Diphtheria	Respiratory	Toxin induces throat inflammation, blockage and paralysis and can be fatal	Inactivated diphtheria toxin (toxoid)
Pertussis	Respiratory	Whooping cough can be fatal in infants.	Inactivated acellular antigen containing pertussis toxoid
Tetanus	Infects dirty or penetrating injuries	Toxin causes paralysis of muscles & breathing. Usually fatal within seven days.	Inactivated tetanus toxin (toxoid)
HIB disease ( <i>Haemophilus influenzae</i> type b)	Respiratory	A cause of ear, nose & throat infection, bronchitis & epiglottitis. Meningitis, bacteraemia are often fatal if untreated.	Type b polysaccharide antigen coupled to a protein carrier to induce an effective response
Tuberculosis ( <i>Mycobacterium tuberculosis</i> )	Respiratory	Attacks lungs most commonly with a 50% mortality if untreated.	BCG vaccine (attenuated myco-bacterial strain) - provides partial protection, preventing disseminated disease in children
Cholera ( <i>Vibrio cholerae</i> )	Faecal contamination of water	High attack rate in non-immune persons exposed to a virulent strain. Profuse watery diarrhoea, dehydration and death if not treated.	Oral live vaccine and heat-killed bacterial vaccine
Typhoid ( <i>Salmonella typhi</i> )	Faecal contamination of food or water	Fever, rash	Oral live vaccine and polysaccharide vaccine
Pneumococcal ( <i>Streptococcus pneumoniae</i> )	Respiratory	Asymptomatic infection is common. A cause of ear, nose & throat infection and bronchitis. Pneumonia, septicaemia & meningitis are often fatal if untreated.	Polysaccharide vaccine, protects against 23 of more than 90 serotypes but not in infants. Conjugated vaccine is effective for infants and children

Meningococci ( <i>Neisseria meningitidis</i> )	Respiratory	Asymptomatic infection is common. Meningitis and septicaemia often fatal if untreated.	Multivalent polysaccharide vaccine (not against commonest serotype B) is also not effective in infants. Type C conjugate vaccine now available. Other conjugate vaccines in development.
Q-fever ( <i>Coxiella burnetii</i> )	Respiratory – transmitted mainly from cattle	Fever, malaise rash and arthritis; rare heart complications & death.	Inactivated vaccine available for those at occupational risk.
<b>Viral diseases</b>			
Hepatitis B	Blood-borne	Acute hepatitis or chronic carriage; liver damage, sometimes fatal; liver cancer in later life.	Purified or recombinant surface antigen provides good protection
Poliovirus	Faecal or respiratory	Asymptomatic infection is common. Paralysis or death in a minority of those infected.	Salk vaccine (inactivated IPV) or OPV (oral polio vaccine); both provide good protection against all 3 serotypes*.
Measles	Respiratory	High attack rate with rash & respiratory symptoms. Pneumonia, meningitis & encephalitis in a minority can be fatal.	Attenuated live measles virus vaccine; highly effective usually given as (MMR).
Mumps	Respiratory	Salivary gland inflammation; orchitis, meningitis and encephalitis and infertility as complications; rarely fatal.	Attenuated live mumps virus vaccine; highly effective usually given as (MMR).
Rubella (German measles)	Respiratory	Rash and joint symptoms; infection in early pregnancy can cause foetal abnormalities and congenital deafness	Attenuated live rubella virus vaccine; highly effective usually given as (MMR).
Varicella (chicken pox)	Respiratory or contact with lesions	Rash and occasional encephalitis; herpes zoster in older subjects.	Attenuated safe and highly effective live varicella vaccine available.
Hepatitis A	Faecal (contact or via food)	Asymptomatic infection is common in children. Liver damage; death is rare.	Inactivated virus vaccine available for travellers and other's at risk provides good protection.

Rabies	Bite of rabid animal	Progressive damage to brain and nervous system; death in 100% of cases after symptoms appear (ie can only treat prior to symptoms).	Inactivated virus vaccine is effective even if given soon after exposure.
Yellow fever	Mosquito vector in Africa and South Americas	Hepatitis, liver failure and death; haemorrhagic lesions.	Attenuated live vaccine provides good protection.
Influenza	Respiratory	Fever, malaise, cough, secondary pneumonia - causes many deaths particularly in elderly.	Type-specific inactivated vaccine for most recent strains.
Smallpox	Respiratory	Fever, rash and haemorrhagic complications; fatality rate of up to 30%.	Live vaccinia vaccine effective in prevention, but with high rate of complications.

⚠ Because poliomyelitis is now almost eradicated from the world, the risk of paralysis from mutation of live OPV (Sabin) virus to cause paralysis (Vaccine Associated Paralytic Polio-VAPP) is now greater than from polio itself. VAPP is exceedingly rare (only one or two cases ever described in Australia, compared to many thousands of past deaths and paralyses caused by polio virus itself). Nevertheless, there is now a rationale to replace OPV with IPV, which as a dead vaccine, could never cause polio.



## APPENDIX 2 CHRONOLOGY OF SCIENTIFIC AND PUBLIC HEALTH ADVANCES IN COMMUNICABLE DISEASES

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BC 400	Hippocrates describes gonorrhoea, malaria and other epidemic fevers
AD 1546	Fracastoro attributes communicable diseases to 'seeds' spread by contact.
1796	Jenner immunises James Phipps with cowpox virus, and shows he is later protected against smallpox, thus founding the science of immunology.
1847	Semmelweiss shows that child-birth fever is preventable by medical attendants washing their hands with chloride of lime, but his work is not accepted by colleagues.
1854	Snow shows that cholera spreads via contaminated drinking water.
1857-1878	Pasteur disproves the theory of spontaneous generation, and shows that putrefaction and infectious disease are caused by living micro-organisms.
1867	Lister shows that antiseptics reduce rates of wound infection after surgery.
1879	Pasteur immunises chickens against chicken cholera using attenuated organisms, and later applies the same principle to anthrax.
1882	Koch discovers the bacillus causing tuberculosis and publishes postulates to be met before a given organism is accepted as causing a disease of interest.
1883	Koch discovers the curved bacillus ( <i>Vibrio</i> ) causing cholera.
1884-1885	Pasteur attenuates rabies virus and successfully immunises dogs and humans.
1885 onwards	Followers of Koch and Pasteur identify bacterial causes of diphtheria, typhoid, pneumonia, gonorrhoea, meningitis, leprosy, plague, tetanus, whooping cough, and syphilis.
1891-1895	Diphtheria antitoxin reduces death rate from diphtheria.
1897	Ronald Ross identifies malarial life-cycle in man and mosquito.
1907-1910	Salvarsan introduced by Ehrlich & Hata to treat syphilis.
1928	Fleming discovered penicillin and its antibacterial effect.
1933	Influenza virus isolated in ferrets at Mill Hill, London.
1935	Domagk introduced prontosil (sulphanilamide) to treat bacterial infection.

1940	Florey, Chain & Heatley purified penicillin and showed its clinical power.
1944	Waksman discovered streptomycin, the first drug against tuberculosis.
1948-1949	Enders grows mumps virus and then poliovirus in tissue culture.
1953	Watson & Crick discover the structure of DNA.
1954	Polio vaccine introduced.
1960-1963	Enders' work leads to attenuated measles virus and licensed vaccine.
1964	Blumberg describes 'Australia antigen' – hepatitis B virus.
1972	Bacterial enzymes allow <i>in vitro</i> manipulation of DNA.
1976	Hepatitis B vaccine available –human derived.
1977	WHO eradicates smallpox – last indigenous case in Somalia.
1983	Montagnier isolates HIV, the AIDS virus; Gallo learns how to grow it.
1984	Recombinant hepatitis B vaccine available.
1985	First conjugate vaccine available (for <i>Haemophilus influenzae</i> type b).
1989	Hepatitis C virus first identified. 1990 routine diagnostic test available.
1994	Full bacterial genome of <i>Haemophilus influenzae</i> sequenced.
1998	Conjugate vaccines available for <i>Streptococcus pneumoniae</i> .
2000	WHO announces polio elimination from Western Pacific region.
2001	Human genome sequence of DNA completed.
2003	Genome of SARS virus sequenced; genomes of most other major pathogens already known.

## APPENDIX 3 COMMUNICABLE DISEASE CONTROL AND RESEARCH - SELECTED AUSTRALIAN EVENTS AND CONTRIBUTIONS

Year	Event or Achievement and its Significance
1770	Seaman from Endeavour dies of TB at Botany Bay.
1789	Smallpox occurs among Aborigines in vicinity of Sydney.
1804	Calf lymph first used in Sydney to vaccinate against smallpox.
1830	Severe smallpox epidemic spreads amongst Aborigines in interior.
1820-1923	Smallpox arrives in 283 vessels, but quarantine is successful in excluding it from spreading from all but 19 vessels.
1853	Leprosy recognised – particularly amongst Chinese on goldfields.
1858	First officially recorded case of diphtheria in Australia.
1880s	Malaria first reported from northern Australia.
1890	Australian TB death rate peaks at about 165 per 100,000. Victorian death rate for diphtheria peaks at 92 per 100,000. NSW death rate from whooping cough at 24 per 100,000.
1895	Diphtheria anti-toxin first used in Australia by Springthorpe First recorded epidemic of poliomyelitis at Port Lincoln, SA.
1890s	Leprosy recognised in Aborigines and others in Northern Territory.
1900	First recorded outbreak of plague in Sydney; periodic outbreaks into the 1920s.
1916	Commonwealth Serum Laboratories set up; takes over manufacture of smallpox vaccine.
1919	Death rate from influenza in NSW peaks at 660 per 100,000 in June.
1925	Australian TB death rate down to 92 per 100,000.
1928	12 children die at Bundaberg after diphtheria immunisation as a result of contamination of re-usable vaccine vials with staphylococcal toxin – outbreak investigated by Burnet.
1936-7	Derrick & Burnet identify cause of Q-fever –later named <i>Coxiella burnetii</i> .
1940	Norman Gregg notices congenital cataract after rubella in early pregnancy Burnet's 'Natural History of Infectious Disease' published – a minor classic.
1944	Bazeley manufactures penicillin at CSL.

- 1951 Fenner, Burnet & Clunies-Ross inject themselves with myxomatosis rabbit virus to show it is harmless, and not the cause of Murray Valley Encephalitis.
- 1950s Mass X-ray screening for TB in Commonwealth control program.
- 1954 Polio vaccine manufactured at CSL; national immunisation starts.
- 1957 CSL produces inactivated vaccine against Asian influenza.
- 1960 Burnet shares Nobel Prize with Peter Medawar for immunological tolerance.
- 1960s Charles Black leads malaria control program to stop transmission in northern Australia  
Last polio epidemics occur in Australia.
- 1973 Causative agents of rotavirus diarrhoea identified by Ruth Bishop, Ian Holmes, Geoff Davidson and Brian Ruck;  
Hepatitis A identified by groups in Melbourne.
- 1977 Fenner chairs the Global Commission for the Certification of Smallpox Eradication.
- 1982 Warren and Marshall discover *Helicobacter pylori* in gastritis, later shown as cause of peptic ulcer;  
Barrie Marmion develops Q Fever vaccine.
- 1980s John Hargrave and others record last cases of active leprosy in Northern Territory.
- 1985 Australia is first country to introduce routine screening of blood donors for HIV and to offer the test to people at risk through selected designated public health laboratories.
- 1989 First National HIV/AIDS Strategy – new infections reduced to 500 per year following awareness and ‘safe sex’ campaign.
- 1996 Doherty shares Nobel prize with Zinkernagel - for discovery of MHC restriction of T-cell killing.
- 1998 Relenza (neuraminidase receptor inhibitor), developed in Australia for influenza treatment.
- June 2000 National Hepatitis C Strategy launched - a world first.
- 2002 Australian research consortium supported to trial their new HIV vaccine.
- 2002 Successful trial of vaccine to prevent papillomavirus infection - based on Australian research - holds promise of preventing cervical cancer.
- 2003 Funding to allow introduction of conjugate vaccine to prevent meningococcal C disease in Australia.

## APPENDIX 4 DISTRIBUTION OF RESISTANCE TO ANTIMICROBIALS AND CHEMOTHERAPEUTIC AGENTS

Infection	Resistance problem	Distribution
<b>Respiratory infection</b>		
<i>Streptococcus pneumoniae</i>	Penicillin resistance, multi-resistance, fluoroquinolone resistance emerging	Worldwide
<i>Haemophilus influenzae</i>	Amoxicillin resistance	Worldwide
<i>Moraxella catarrhalis</i>	Amoxicillin resistance	Worldwide
<i>Pseudomonas aeruginosa</i>	Multi-resistance	Worldwide in cystic fibrosis patients
<i>Mycobacterium tuberculosis</i>	Isoniazid resistance, multi-resistance	North America, developing countries
<b>Skin, soft tissue &amp; bone infection, and Septicaemia</b>		
<i>Staphylococcus aureus</i>	Penicillin resistance	Worldwide
	Methicillin-resistance	Worldwide in hospitals and community strains are now appearing
	Vancomycin resistance at intermediate (VISA) and complete levels (VRSA)	Australia has reported cases of VISA, the first cases of VRSA was reported in 2002
<i>Streptococcus pyogenes</i>	Erythromycin (macrolide) resistance	Worldwide
<b>Urinary tract infection, Septicaemia</b>		
<i>Escherichia coli</i>	Amoxicillin resistance, fluoroquinolone resistance, multi-resistance	Worldwide
<i>Klebsiella</i> species	Third-generation cephalosporin resistance, multi-resistance	Worldwide
<i>Proteus mirabilis</i>	Amoxicillin resistance	Worldwide
<b>Health-Care associated infections</b>		
<i>Staphylococcus aureus</i>	Methicillin resistance, multi-resistance	Worldwide

<i>Enterococcus faecium &amp; faecalis</i>	Vancomycin (glycopeptide) resistance	North America, Europe, Australia
<i>Enterobacter species</i>	Third - and fourth generation cephalosporin resistance	Worldwide
<i>Acinetobacter species</i>	Multi-resistance	Worldwide
<b>Gastro-Enteritis</b>		
<i>Salmonella species</i>	Multi-resistance	Worldwide
<i>Campylobacter species</i>	Fluoroquinolone resistance	North America, Europe
<b>Malaria</b>		
<i>Plasmodium falciparum</i> *	Chloroquine resistance	India, much of Africa and most tropical areas. Multi-resistance is present in Southeast Asia.

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\* **Malaria** is caused by a protozoal (single-celled) parasite, not a bacterium. However, the emergence of resistance in malaria is analogous to the emergence of anti-microbial resistance in bacteria.



## APPENDIX 5 DISEASES INCLUDED IN THE NATIONAL NOTIFIABLE DISEASES SURVEILLANCE SCHEME

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### **Bloodborne**

hepatitis B, hepatitis C, hepatitis D, hepatitis (not elsewhere classified)

### **Gastrointestinal**

botulism, campylobacteriosis, cryptosporidiosis, Haemolytic Uraemic Syndrome, hepatitis A, hepatitis E, listeriosis, salmonellosis, shigellosis, shiga-like toxin and vero-like toxin producing *E. coli* (SLTEC, VTEC), typhoid

### **Quarantinable**

cholera, plague, rabies, viral haemorrhagic fever, yellow fever, smallpox, Severe Acute Respiratory Syndrome (SARS)

### **Sexually transmissible**

chlamydial infection, donovanosis, gonococcal infection, syphilis

*(HIV is notifiable and is reported in a separate scheme to the NNDSS)*

### **Vaccine preventable**

diphtheria, *Haemophilus influenzae* type b, influenza, measles, mumps, pertussis, pneumococcal disease, poliomyelitis, rubella, tetanus, smallpox

### **Vectorborne**

arbovirus infection not elsewhere classified (NEC), barmah forest virus infection, dengue, japanese encephalitis, kunjin, malaria, murray valley encephalitis, ross river virus infection

### **Zoonoses**

anthrax, Australian bat lyssavirus, brucellosis, leptospirosis, ornithosis, Hendra, Nipah, Q fever

### **Other bacterial infections**

legionellosis, leprosy, meningococcal infection, tuberculosis, anthrax

## APPENDIX 6 CDC CATEGORISATION OF POSSIBLE AGENTS OF BIOLOGICAL ATTACK

Category		Disease
A	Agents posing highest potential risk	smallpox, anthrax, plague, botulism, tularaemia, and viral haemorrhagic fevers.
B	Moderately easy to disseminate, moderate morbidity, low mortality	Food and water contamination ( <i>E. coli</i> , <i>Salmonella</i> , <i>cholera</i> , <i>Cryptosporidium</i> ) Viral encephalitides caused by alpha viruses (equine encephalitis).
C	Emerging infectious disease	Nipah virus affecting mainly swine has caused human cases of encephalitis in Malaysia. Hantaviral disease infects rodents worldwide and occasionally caused disease in humans.

See also the CDC web-sites <sup>63</sup>

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See also the Bovine spongiform encephalopathy (BSE) section on the World Health Organization web site: <<http://www.who.int/csr/disease/bse/en/>>.

<sup>60</sup> National Health and Medical Research Council 2003, NHMRC Special Expert Committee on Transmissible Spongiform Encephalopathies (SECTSE), NHMRC, Canberra, <<http://www.nhmrc.gov.au/sectse/contents.htm>>.

<sup>61</sup> Medical and scientific journals published articles on SARS quickly. The scientific literature can be accessed through a number of sources, including the PubMed web site at: <<http://www.ncbi.nlm.nih.gov/entrez/query.fcgi>> and then follow the SARS prompt on this site.

<sup>62</sup> Miller J, Engelberg S, Broad W. Germs: the ultimate weapon. New York: Simon and Schuster, 2001.

<sup>63</sup> Papers describing the US response can be found on the Public Health and Preparedness Response section on the Centers for Disease Control and Prevention web site: <<http://www.bt.cdc.gov/>>.

<sup>64</sup> Smallwood RA, Merianos A, Mathews JD. Bioterrorism in Australia. *Med J Aust* 2002;176(6):251-3.

See also Australia's Biosecurity Response section on the Department of Health and Ageing web site: <<http://www.health.gov.au/pubhlth/strateg/bio/index.htm>>.

<sup>65</sup> See the Communicable Disease Australia web site which provides access to data and articles about communicable diseases and surveillance activities in Australia: <<http://www.cda.gov.au/cdna/index.htm>>.

<sup>66</sup> Postgraduate students can train in communicable disease through the Master of Applied Epidemiology program at the National Centre for Epidemiology and Population Health. Information on the program is available on the NCEPH web site: <[http://nceph.anu.edu.au/Teaching\\_Programs/MAE.htm](http://nceph.anu.edu.au/Teaching_Programs/MAE.htm)>.

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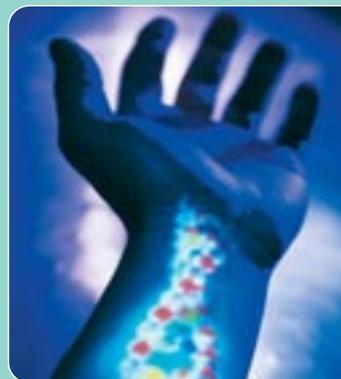
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