

# Fighting Infectious Diseases

Volume | 419



Edited by Justin Healey

**ISSUES**  
**IN SOCIETY**

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 **THE SPINNEY PRESS**

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# INTRODUCTION

**Fighting Infectious Diseases** is Volume 419 in the 'Issues in Society' series of educational resource books. The aim of this series is to offer current, diverse information about important issues in our world, from an Australian perspective.

## KEY ISSUES IN THIS TOPIC

Infectious, or communicable, diseases are a major global health concern. Managing and preventing the spread of diseases takes a concerted public health effort to deal with deadly outbreaks, epidemics and pandemics.

What are the various ways in which infectious diseases are spread? How much of a threat are emerging infections such as Ebola, SARS and the Zika virus to large populations of people? And how much of a concern is the growth in antimicrobial resistance to drugs, such as antibiotics, which are routinely used to treat infection?

The World Health Organization estimates that vaccines prevent 2-3 million deaths every year; how effective has immunisation been in Australia at containing and eradicating vaccine-preventable diseases? What are the myths and facts regarding the safety and effectiveness of vaccines, and why do some misconceptions among immunisation objectors persist?

This book reveals the global trends and challenges in the fight against the major types of infectious disease, and looks at vaccine-preventable diseases and immunisation in Australia. Are we doing enough to win the ongoing fight against infectious diseases?

## SOURCES OF INFORMATION

Titles in the 'Issues in Society' series are individual resource books which provide an overview on a specific subject comprised of facts and opinions.

The information in this resource book is not from any single author, publication or organisation. The unique value of the 'Issues in Society' series lies in its diversity of content and perspectives.

**The content comes from a wide variety of sources and includes:**

- Newspaper reports and opinion pieces
- Website fact sheets
- Magazine and journal articles
- Statistics and surveys
- Government reports
- Literature from special interest groups

## CRITICAL EVALUATION

As the information reproduced in this book is from a number of different sources, readers should always be aware of the origin of the text and whether or not the source is likely to be expressing a particular bias or agenda.

It is hoped that, as you read about the many aspects of the issues explored in this book, you will critically evaluate the information presented. In some cases, it is important that you decide whether you are being presented with facts or opinions. Does the writer give a biased or an unbiased report? If an opinion is being expressed, do you agree with the writer?

## EXPLORING ISSUES

The 'Exploring issues' section at the back of this book features a range of ready-to-use worksheets relating to the articles and issues raised in this book. The activities and exercises in these worksheets are suitable for use by students at middle secondary school level and beyond.

## FURTHER RESEARCH

This title offers a useful starting point for those who need convenient access to information about the issues involved. However, it is only a starting point. The 'Web links' section at the back of this book contains a list of useful websites which you can access for more reading on the topic.

# CHAPTER 1

## Global trends and challenges

### WAYS INFECTIOUS DISEASES SPREAD

#### FACT SHEET ADVICE FROM SA HEALTH

**T**here are several different ways in which infectious diseases can be spread, according to the following advice.

Germ can spread through:

- The air as small droplets (droplet spread) or tiny aerosol particles (airborne spread)
- Contact with faeces (poo) and then with the mouth (faeco-oral spread)
- Contact with the skin or mucous membranes (the thin moist lining of many parts of the body such as the nose, mouth, throat and genitals) (contact spread)
- Blood or other body fluids (for example, urine, saliva, breastmilk, semen and vaginal secretions).

Germ can spread:

- Directly from person to person or
- Indirectly from an infected person to the environment (for example toys, door handles, bench tops, bedding and toilets) and then to another person who comes in contact with the contaminated environmental source.

Germ can enter the body through the:

- Mouth
- Respiratory tract
- Eyes
- Genitals
- Broken skin.

Some infections can be spread in several different ways.

There are other ways of describing how germs are spread that are commonly used.

Germ can be spread through sexual contact, which is usually through semen and vaginal secretions (body fluids), but can also occur through contact with mucous membranes.

Germ can spread through food or water. Many but not all the germs spread in this way are through contact with faeces and then with the mouth (faeco-oral).

Germ can also spread from a mother to her unborn child, usually through blood (body fluids) but also through contact with skin or mucous membranes during delivery.

#### What are infectious diseases?

- Infectious diseases are disorders caused by organisms – such as bacteria, viruses, fungi or parasites. Many organisms live in and on our bodies. They're normally harmless or even helpful, but under certain conditions, some organisms may cause disease.
- Some infectious diseases can be passed from person to person. Some are transmitted by bites from insects or animals. And others are acquired by ingesting contaminated food or water or being exposed to organisms in the environment.
- Signs and symptoms vary depending on the organism causing the infection, but often include fever and fatigue. Mild infections may respond to rest and home remedies, while some life-threatening infections may require hospitalisation.
- Many infectious diseases, such as measles and chickenpox, can be prevented by vaccines. Frequent and thorough hand washing also helps protect you from most infectious diseases.

Mayo Foundation for Medical Education and Research (2016). *Infectious diseases: Overview*. Retrieved from [www.mayoclinic.org](http://www.mayoclinic.org) on 12 September 2016.





*Adapted from National Health and Medical Research Council – ‘Staying Healthy: preventing infectious disease in early childhood education and care services’, 5th Edition 2012.*

### **Spread through the air by droplets**

Some infections are spread when an infected person talks, coughs or sneezes small droplets containing infectious agents into the air. Due to their size, these droplets in the air travel only a short distance (around a metre) from the infected person before falling. The droplets in the air may be breathed in by those nearby. Spread can also occur by touching the nose or mouth with droplet contaminated hands.

Examples of droplet spread diseases:

- Common cold
- Flu
- Meningococcal disease
- Rubella.

### **Spread through the air by aerosol**

Some infections are spread when an infected person talks, breathes, coughs or sneezes tiny particles containing infectious agents into the air. These are called small particle aerosols. Due to their tiny size, small particle aerosols can travel long distances on air currents and remain suspended in the air for minutes to hours. These small particle aerosols may be breathed in by another person.

Examples of airborne spread diseases:

- Chickenpox
- Measles
- Tuberculosis (TB).

### **Spread through faeces and then the mouth (faecal-oral spread)**

Some infections are spread when microscopic amounts of faeces (poo) from an infected person with symptoms or an infected person without symptoms (a carrier) are taken in by another person by mouth.

The faeces may be passed:

- Directly from soiled hands to the mouth
- Indirectly by way of objects, surfaces, food or water soiled with faeces.

Examples of diseases spread from faeces:

- *Campylobacter* infection
- *Cryptosporidium* infection
- *Giardia* infection
- Hand, foot and mouth disease
- Hepatitis A
- Meningitis (viral)
- Rotavirus infection
- *Salmonella* infection
- *Shigella* infection
- Thrush
- Viral gastroenteritis
- Worms
- *Yersinia* infection.

### **Spread by skin or mucous membrane contact**

Some infections are spread directly when skin or mucous membrane (the thin moist lining of many parts of the body such as the nose, mouth, throat and genitals) comes into contact with the skin or mucous membrane of another person. Infections are spread indirectly when skin or mucous membrane comes in contact with contaminated objects or surfaces.

Examples of diseases spread by skin or mucous membrane contact:

- Chickenpox
- Cold sores (herpes simplex infection)
- Conjunctivitis
- Hand, foot and mouth disease
- Head lice
- Molluscum contagiosum
- Ringworm
- Scabies
- School sores (impetigo)
- *Staphylococcus aureus* infection
- Warts.

### **Spread through blood or other body fluids**

Some infections are spread when blood or other body fluids (for example, urine, saliva, breastmilk, semen and vaginal secretions) from an infected person comes into contact with:

- The mucous membranes (the thin moist lining of many parts of the body such as the nose, mouth, throat and genitals), such as through kissing, breast-feeding or sexual contact or
- The bloodstream of an uninfected person, such as through a needle stick injury or a break in the skin.

Examples of diseases spread through blood or other body fluids:

- Hepatitis B – blood, saliva, semen and vaginal fluids
- Hepatitis C – blood
- Human immunodeficiency virus (HIV) infection – blood, semen and vaginal fluids, breastmilk
- Cytomegalovirus (CMV) infection – saliva, breastmilk, semen and vaginal fluids, urine
- Glandular fever – saliva.

### **Other ways of describing how infectious diseases are spread**

#### **Spread through sexual contact (sexually transmitted infections)**

These infections are most commonly transmitted by sexual contact.

Sexual contact means:

- Genital to genital
- Oral to genital
- Genital to anal.

Examples of sexually transmitted infections:

- *Chlamydia* infection
- Genital herpes
- Genital warts
- Gonorrhoea
- Hepatitis B
- Human immunodeficiency virus (HIV) infection
- Non-specific urethritis (NSU)
- Pubic lice (crabs)
- Syphilis
- Trichomoniasis.

### **Spread through food or water**

These diseases result from ingestion of water or a wide variety of foods contaminated with disease-causing germs or their toxins. Often these infections are also spread by the faecal-oral route.

Examples of food or waterborne diseases:

- Botulism
- *Campylobacter* infection
- Cholera
- *Cryptosporidium* infection
- Haemolytic uraemic syndrome
- *Listeria* infection
- *Salmonella* infection
- *Shigella* infection
- Typhoid and paratyphoid
- *Yersinia* infection.

### **Spread from a mother to her unborn child**

Some infections can be spread through the placenta from a mother to her unborn child or during delivery, or both.

Examples of diseases spread from a mother to child in this way:

- Chickenpox
- Hepatitis B
- Rubella.

### **Diseases where person-to-person spread occurs rarely, if ever**

Some infectious diseases are almost never spread by contact with an infected person. These diseases are usually spread by contact with an environmental source such as animals, insects, water or soil.

Examples of diseases spread by contact with animals:

- Cat-scratch disease
- Hydatid disease
- Psittacosis
- Q fever
- Rabies
- Toxoplasmosis.

Examples of diseases spread by insects, and in the examples listed below, specifically by mosquitoes:

- Barmah Forest virus infection
- Dengue fever
- Malaria
- Ross River virus infection.

Examples of diseases spread by contact with water or soil:

- Amoebic meningitis
- *Legionella* infection – *Legionella pneumophila* and *Legionella longbeachae*
- Tetanus.

Reproduced with permission from SA Health, Government of South Australia.

SA Health (2012). *Ways infectious diseases spread*. Last modified 3 February 2016. Retrieved from [www.sahealth.sa.gov.au](http://www.sahealth.sa.gov.au) on 19 September 2016.

# WHAT'S THE DIFFERENCE BETWEEN AN OUTBREAK AND AN EPIDEMIC?

**Arinjay Banerjee** explains the distinction between the two terms in response to news of the recent global spread of emerging infectious diseases

**M**ore than 8,000 people have died from Ebola in West Africa since February 2014 and it has spread beyond the three countries initially affected. So, it's an epidemic, right? Or is it an outbreak?

What about H1N1? The 2009 pandemic infected people around the world. But, so did the SARS epidemic in 2003. What's the difference between an epidemic and pandemic? What about diseases like malaria and dengue? Dengue fever infects between 50 and 100 million people each year in countries all over the world. So that's the same thing as a pandemic? Not quite. Maybe you've seen headlines about West Nile Virus, Chikungunya fever or Middle East Respiratory Syndrome. And what are emerging and reemerging diseases?

It's time to brush up on the vocabulary that can help you understand just what infectious disease experts are trying to tell us.

## Outbreaks, epidemics and pandemics

An outbreak is the sudden occurrence of a disease in a community, which has never experienced the disease before or when cases of that disease occur in numbers

greater than expected in a defined area. The current Ebola scenario in West Africa started as an outbreak, which initially affected three countries.

An outbreak is the sudden occurrence of a disease in a community, which has never experienced the disease before or when cases of that disease occur in numbers greater than expected in a defined area.

So what exactly is an epidemic? It is an occurrence of a group of illnesses of similar nature and derived from a common source, in excess of what would be normally expected in a community or region. A classic example of an epidemic would be Severe Acute Respiratory Syndrome (SARS). The epidemic killed about 774 people out of 8,098 that were infected. It started as an outbreak in Asia and then spread to two dozen countries and took the form of an epidemic. The same is true for Ebola, which is now being termed an epidemic.

A pandemic on the other hand refers to a worldwide epidemic, which could have started off as outbreak, escalated to the level of an epidemic and eventually spread to a number of countries across continents. The 2009 flu pandemic is a good example. Between the period of April 2009 and August 2010, there were approximately 18,449 deaths in over 214 countries. The flu virus (H1N1) probably originated in Mexico and within two months, sustained human-to-human transmission in several countries on different continents was reported, prompting the WHO to announce the highest alert level (phase 6, pandemic) on June 12, 2009.

## Endemic diseases

Some diseases can remain active in a given area for years and years. A disease is described as endemic when it is habitually present within a given geographic area. For example, dengue, which is spread by mosquitoes, is endemic in more than 100 countries. So why isn't dengue considered a pandemic yet? The point to consider here is that the dengue cases are not from a common source. Mosquitoes do not fly beyond a few hundred meters, so the cases in each country are from a different source. Rotavirus-induced infant diarrhea is another example of an endemic disease, which is rampant in developing countries.

## Emerging and re-emerging diseases

We also come across words like 'emerging' and 're-emerging'. An emerging disease is one that has





appeared in a population for the first time or one which may have existed before, but is rapidly increasing in incidence. Examples of emerging infectious diseases are SARS, HIV and H1N1.

Despite advances made in the field of medicine, global travel has added to the complexity of controlling infectious diseases. Both the 2003 SARS epidemic and the 2009 H1N1 pandemic were spread to a large extent due to air travel.

Chikungunya is another viral disease that is emerging in the Western Hemisphere. The first known cases in the Western Hemisphere occurred around October 2013 among residents of the French side of St. Martin in the Caribbean. WHO confirmed more than 31,000 probable and confirmed cases, which were not imported but indigenous in nature, from numerous other Caribbean islands as of April 2014.

Middle East Respiratory Syndrome (MERS) emerged around April 2012 and has affected countries in the Middle East, Europe, Africa, Asia and North America, with 945 human cases, including 348 deaths as of January 6, 2015.

An epidemic is an occurrence of a group of illnesses of similar nature and derived from a common source, in excess of what would be normally expected in a community or region.

Reemerging diseases are those that have historically infected humans, but continue to appear in new locations or reappear after apparent control or

elimination. Most of the reemerging disease agents appeared long ago and have survived and persisted in the environment. A classic example is the West Nile virus (WNV). It is thought that WNV arrived in the United States via an infected traveller, bird or mosquito, which entered America through air travel from the Middle East.

A pandemic on the other hand refers to a worldwide epidemic, which could have started off as outbreak, escalated to the level of an epidemic and eventually spread to a number of countries across continents.

### Why bother?

Although people use terms like outbreak and epidemic interchangeably, it would only be fair to understand the definitive meaning behind each word. An outbreak can take the form of an epidemic and eventually a pandemic, but that does not entitle us to use these words incorrectly.

**Arinjay Banerjee** is a PhD Candidate in Veterinary Microbiology, University of Saskatchewan.

## THE CONVERSATION

Banerjee, A (7 January 2015). *Explainer: what's the difference between an outbreak and an epidemic*. Retrieved from <https://theconversation.com> on 13 September 2016.

# A history of plagues, pandemics and Ebola

*With health authorities struggling to contain an outbreak of the deadly Ebola virus in West Africa, Annabelle Quince from **ABC Radio National** takes a look at the history of plagues and pandemics around the world, from the Dark Ages until the modern day*

**T**he current outbreak of Ebola in West Africa first appeared in Guinea in March, and is the largest outbreak ever recorded, both in terms of geographic spread and number of people infected. To date, infections have been recorded in Guinea, Sierra Leone, Liberia and Nigeria, with an estimated 2,615 people affected, half of whom have died.

Ebola first emerged in 1976 in the Democratic Republic of the Congo, and since then there have been between 40 and 42 outbreaks, all of which have been contained. While the current outbreak hasn't yet spread beyond West Africa, it has raised a number of questions about how we deal with disease and infections in the 21st century.

According to medical geographer Joseph Oppong, professor of geography at the University of North Texas, one of the key reasons this outbreak has not been able to be contained is due to where began, the city of Guéckédou in Guinea.

"The borders of the three countries almost intersect right there," he says. "In many countries the political boundaries are not respected by the people. So in this present case you have a death occurring in Guéckédou ... and people from neighbouring countries – same families, same people – came to the funeral and they carried the disease with them to the other countries."

"If the outbreak had been in some rural community far removed from the urban centres, ordinarily it

would be easy to just contain that, or if it is just a small population maybe it wipes them out and then it is contained, like a quarantine type situation. But what you have is that the disease is now being carried into the urban areas where you have a lot of population. So when it is in Monrovia, when it is in the large cities in these countries it becomes much, much more difficult to control."

The other factor that has played a major role in the current outbreak has been the improvement of transport infrastructure in West Africa over recent decades. Roads have been built and people routinely use scooters and motorcycles as taxis over long distances. Even so, it can be difficult to even identify outbreaks considering the general level of poverty and lack of effective surveillance.

Ebola, like other recently emerged diseases, like AIDS in Africa or SARS in Asia, originated in the developing world. Professor Oppong argues that this is because public health systems in poor countries are either non-existent or underdeveloped.

Associate Professor Susan Craddock from Institute for Global Studies at the University of Minnesota and author of *Diseases: Emerging Infections in the Global City*, agrees. She argues that if Ebola had emerged in the United States, Australia or Europe it would have been contained quite quickly.

"It is not a contagious airborne disease, as SARS was, as influenza always is, as tuberculosis is," she says.

"Not all health care workers in Liberia, Guinea and Sierra Leone have access to the kind of protective measures that are necessary when handling patients, when handling bodies and you are invariably going to come into contact with sweat, potentially with blood [and] with saliva."

"When you are caring for patients that do have Ebola and you don't have the kinds of gloves and suits and protective clothing that you need, you are putting yourself at very high risk."

"In the United States, in Australia and the EU, we have those readily available for us."

The fear is that a disease that is much harder to contain could emerge in Africa or Asia which could turn into a pandemic. A pandemic is an epidemic of infectious disease that spreads through human populations across multiple continents or even worldwide.

The first recorded pandemic occurred in the sixth century and is known as the Justinian Plague. It was followed in the 14th century by the Black Death; both are thought to have been caused by the bubonic plague, which is spread by infected fleas that live on infected rats.

The plague had been circulating Ethiopia and



adjoining parts of Africa, but had not been able to reach Europe because of temperatures in the Sahara Desert and along the Red Sea, which were too hot for the fleas to reproduce. That all changed in 530AD, when an enormous volcanic eruption in Indonesia plunged the world into a cool period for a decade.

“That seems to have opened up the path for the rats and the infected fleas to accompany the grain boats heading up to the Mediterranean to supply the hungry Eastern Roman Empire,” says Tony McMichael, professor emeritus of population health at ANU. “That was a great chance for the rats to go with the grain, feed on it, proliferate, and so did their fleas.”

“When they got to Constantinople the disease spread in devastating fashion and wiped out about a third of the population of half a million in about three months’ time. After that the rats spread widely, the disease with them, and another maybe 50 million to 70 million people were killed over the ensuing two or three centuries.”

During these early pandemics people didn’t understand what caused disease and infection and believed they were the work of an angry deity. They were seen as divine punishment for society’s ills.

During the period of the Black Death in Europe, advisers to popes and emperors claimed the outbreak was due to the alignment of the planets or the passing of comets. There was also scapegoating of ethnic minorities, particularly the Jews, who were accused of poisoning the wells in Central Europe, leading to pogroms and massacres.

The diseases that spread globally during the Middle Ages until the 19th century were smallpox, cholera, and plague. In the late 19th century, yellow fever began spreading in the Americas, and there was fear that it would also become a worldwide disease.

It wasn’t till the end of the 19th century that a true understanding of how disease was spread developed. A cholera outbreak in London was contained when John Snow mapped all the houses affected, deducing that cholera was spread via contaminated water.

Once understanding of what caused disease and how it spread developed, modern medicine advanced quickly. By the middle of the 20th century, many diseases were no longer thought to be a threat. Edward Jenner famously developed a vaccine for smallpox, rats and mosquitoes were controlled and public sanitation improved.

While the advent of penicillin led to a decline in many infectious diseases, Professor Craddock argues it also led to complacency.

“With the development of antibiotics there was a huge sense, and understandably so, that finally many infectious diseases, those of course caused by bacteria not viruses but diseases like tuberculosis, could finally be cured,” she says.

The irony is that at the very moment doctors started to believe they could eradicate or cure many of the traditional disease that have afflicted humankind

two things happened: traditional diseases started to re-appear and new diseases, like Ebola, AIDS and SARS, emerged.

“We’ve made good headway against a number of these diseases, but it’s an illusion to imagine that we can live in a microbe-free world,” says Professor McMichael. “Frankly they’ve been around a lot, lot longer than we have and they are very fleet-footed genetically, they adapt very quickly to changing circumstances, including the use of antibiotics.”

It is not a sexy disease, it is not a disease that affects the rich developed world. It affects a small number of people. It is not in the interest of big pharmaceutical companies to invest a lot of money in research on Ebola.

Professor Joseph Oppong, medical geographer.

“We haven’t managed to get very far with malaria, we’re struggling to get a vaccine for HIV still. It’s extraordinary to look back now to the 1940s and ’50s when there was an expectation that with the advent of penicillin we would find ways of actually wiping out all of these serious infectious agents.”

“The story goes on, and we are going to have to be on our mettle to keep on top of this in a world that’s increasingly interconnected and where, for the moment, the antibiotics that we are using are generally losing their potency.”

Professor Oppong argues that that one of the best things the west can do to protect itself against another pandemic is to help support the health services of developing nations like those currently battling with Ebola.

“Ebola has been around since 1976,” he says. “How come we have not developed medications for it or vaccines for it?”

“The reason is it is not a sexy disease, it is not a disease that affects the rich developed world. It affects a small number of people. It is not in the interest of big pharmaceutical companies to invest a lot of money in research on Ebola.”

“The best thing the developed world can do in terms of protecting themselves from diseases is to help the developing world, the poorer countries, to improve their own health care systems, surveillance systems, so that we can identify outbreaks when they occur very early and then we can contain them.”

“A disease outbreak anywhere on the surface of the Earth puts every person at risk.”

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Quince, A (2 September 2014). *A history of plagues, pandemics and Ebola*. Retrieved from [www.abc.net.au/radionational](http://www.abc.net.au/radionational) on 14 September 2016.

# Global trends in human infectious disease: RISING NUMBER OF OUTBREAKS, FEWER PER-CAPITA CASES

By **Natasha Sokol** and **Denise-Marie Ordway** from Harvard Kennedy School's Shorenstein Center on Media, Politics and Public Policy

The 2014 Ebola outbreak in West Africa dramatically raised awareness of the global burden of infectious disease and raised questions about the preparedness of public health systems. In February 2016, the public scrambled to understand the implications of the Zika virus after the World Health Organization designated it as an international public health emergency because of the suspected relationship between Zika and a rise in cases of a rare congenital condition called microcephaly in Brazil. Although non-communicable diseases are the leading cause of morbidity and mortality in most developed nations, infectious disease remains a major public health concern in the United States and around the world.

Defining and examining the global distribution of infectious disease, in both time and location, is a major research priority. These “spatio-temporal patterns” allow researchers to examine how and why infectious disease does or does not spread. Three terms are used in epidemiology – the study of the spread, causes and consequences of disease – to describe disease distribution:

- **Epidemic:** A widespread increase in the observed rates of disease in a given population. Diseases such as mumps, measles and cholera can become epidemics, depending on a range of factors.

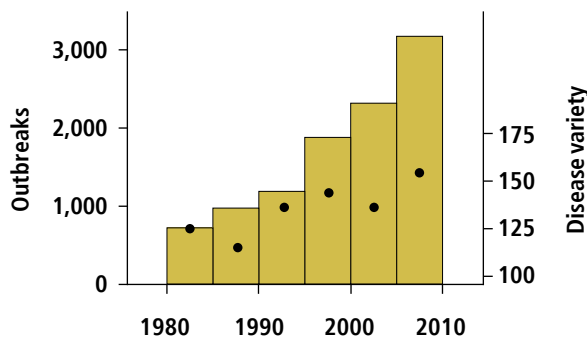
- **Endemic:** A consistently heightened rate of disease observed in and associated with a given population over time. For example, malaria is endemic in a number of tropical zones in the world.
- **Pandemic:** A sudden increase in the observed rates of disease across many populations globally. The most infamous is the 1918-19 flu pandemic, which killed 675,000 people in the United States and millions around the globe.

Note that the term ‘outbreak’ can refer to an epidemic or pandemic. Epidemiologists’ ability to define a disease distribution as epidemic, endemic or pandemic allows health workers, clinicians and policy makers to set local and global priorities for controlling illness and promoting health throughout a population level.

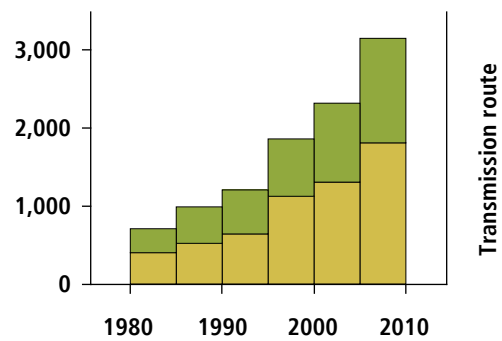
*The term ‘outbreak’ can refer to an epidemic or pandemic. Epidemiologists’ ability to define a disease distribution as epidemic, endemic or pandemic allows health workers, clinicians and policy makers to set local and global priorities for controlling illness and promoting health throughout a population level.*



## OUTBREAKS RISE AND CHANGE, WHILE PER-OUTBREAK CASES FALL



Since 1980 the global number of disease outbreaks has risen (olive bars, left axis) while the variety of diseases (dots, right axis) has also increased.



The proportions of diseases transmitted by animals and others vectors (in green) has also risen relative to those that are human-specific (in olive).

\*'Global Rise in Human Infectious Disease Outbreaks', *Journal of the Royal Society Interface*, 2014.

A 2014 study published in the *Journal of the Royal Society Interface*, 'Global Rise in Human Infectious Disease Outbreaks', examines the global changes in the frequency of outbreaks of infectious disease between 1980 and 2013. In all, the dataset covered 12,102 outbreaks of 215 diseases, with 44 million individual cases in 219 countries around the world. The researchers, based at Brown University, sought to examine the relationship between the location and timing of disease outbreaks and the characteristics of outbreak sites, such as the presence of certain animals that transmit disease to humans.

The study's findings include:

- The number of outbreaks, and the number of kinds of disease, have both increased significantly since 1980.
- While the number of outbreaks appears to be increasing over time, the data suggest that per-capita outbreak cases are declining: "Despite an increase in overall outbreaks, global improvements in prevention, early detection, control and treatment are becoming more effective at reducing the number of people infected."
- During the study period, 31% of all human-specific infectious diseases represented 80% of all outbreaks.
- Stomach flu (viral gastroenteritis) caused the greatest number of cases of infectious disease, 15 million, while salmonellosis – an infection typically contracted from consuming food containing salmonella bacteria – was responsible for the greatest number of outbreaks, 855.
- In the data analysed, 65% of the diseases, making up 56% of all outbreaks, were 'zoonoses,' meaning that they were transmissible to humans by animals, insects and other vectors. These include Ebola, HIV, the bubonic plague and Lyme disease.
- Zoonotic diseases have been becoming increasingly diverse over time, but only a small number cause the majority of outbreaks in each decade: "From 1980 to 1990, 80% of all zoonotic disease outbreaks were caused by only 25% of potential zoonoses in

the dataset, and only 22% and 21% of zoonoses from 1990 to 2000 and from 2000 to 2010, respectively." The authors caution that zoonotic disease cases may be undercounted in the nations affected the most because of limited infrastructure and health resources.

- "In contrast to zoonoses ... human-specific diseases are declining in diversity and in the impact they have through outbreaks (in terms of per-capita cases)."

The scholars control for the possible confounding role of the internet, starting in 1990, but note that "it is beyond the scope of this report and our current dataset to determine the role the internet has played in outbreak detection and reporting." However, they state that "it is becoming increasingly clear that the internet can improve disease reporting by supplementing formal surveillance with publicly generated digital disease surveillance."

### RELATED RESEARCH

- A 2014 report by the US Centers for Disease Control and Prevention found that salmonella was responsible for more cases of illness, hospitalisations and deaths than any other food-borne pathogen.
- A 2012 study published in *Lancet Infectious Diseases* reviews non-infectious disease risks from mass-gatherings.
- A 2011 report by the World Health Organization reviewed the causes of death globally, and identified ways by which to measure progress in infectious disease, among other types and indicators of morbidity and mortality.

Smith, KF, Goldberg, M, Rosenthal, S, Carlson, L, Chen, J, Chen, C and Ramachandran, S (1 February 2016). 'Global trends in human infectious disease: Rising number of outbreaks, fewer per-capita cases', *Journal of the Royal Society Interface*. Retrieved from <http://journalistsresource.org> on 14 September 2016.

# DISEASE EVOLUTION: OUR LONG HISTORY OF FIGHTING VIRUSES

Humans have a deep history of viral infections, explains **Peter Doherty** in this article first published in *The Conversation*

A virus is essentially an information system (encoded in DNA or RNA) surrounded by a protective coat and shaped by evolution to ensure its own replication and survival.

Viruses grow only in living cells. But they infect everything from the simplest, single-cell organisms, such as amoebae, to multicellular, multi-organ ecosystems like us.

Bacteria, on the other hand, are cells in their own right and carry all the molecular machinery needed for their reproduction. As a consequence, they have unique biochemical pathways that can be targeted by broad-spectrum antibiotics.

Antiviral drugs tend to be unique for the particular virus, or closely related family of viruses. This has made them much less available than antibacterial drugs.

## *Tracing our molecular history*

Evidence of our long history of infection is found in ancient fragments of viral DNA that have passed from mother to foetus. These are not known to cause problems and may even be of some benefit.

Every human also has a 'virome' of persistent pathogens they've contracted since birth. Herpes simplex type 1 (which causes cold sores), Epstein Barr virus (which causes glandular fever or 'kissing disease' in adolescents) and cyto-megalovirus (also a member of the herpes family), for instance, stay with us for life.

Gene sequence analysis allows us to infer how long *Homo sapiens* has been associated with particular viruses. There is evidence, for example, that lineages of human T cell leukemia virus type 1 (HTLV1), a virus that grows only in us to cause leukemia and other diseases,

has been around for many thousands of years.

The original Australians carry two 'strains' of HTLV1 that are thought to have diverged more than 9,000 years back and which are a significant and under-recognised cause of illness in some indigenous communities.

## *Piecing together the rest*

Humans have a deep history of viral infections, but other than the molecular analysis of current or recently circulating pathogens, the data is fragmentary.

That may change as researchers probe more ancient DNA from Egyptian mummies, where there is evidence of lethal tuberculosis and malaria (neither of which is viral) dating 1,500 to 4,000 years back. The evidence so far suggests mummies suffered from smallpox and polio.

With recorded history, we are limited to much more recent accounts. From 430-427 BCE, the Plague of Athens, described by Thucydides, killed more than one-third of the population. The cause is unknown, though the favoured candidate is the bacterial infection typhus.

Then the Antonine plague (165-180 CE), also called the Galenic plague after the great Roman physician, was likely viral, with smallpox being the probable cause.

Chinese paediatrician Wan Quan (1495-1585) identified smallpox and, around that time, the Chinese began the process of 'immunising' healthy subjects by blowing powdered smallpox scab material up the nose.

Recognisable descriptions of influenza outbreaks date back to 1580, with three such events during each of the 19th and 20th centuries.

Setting aside HIV/AIDS, which may be regarded as a 'continuing' (since 1981) pandemic, the worst pandemic of modern times was the 1918-19 Spanish flu that killed

A virus is essentially an information system (encoded in DNA or RNA) surrounded by a protective coat and shaped by evolution to ensure its own replication and survival.



40-50 million people globally. Spain gets a bad rap for this: the virus had been active in the trenches on the western front for months, but neither set of combatants wanted to admit their armies were being weakened.

We don't know if a milder variant of this virus was circulating in France the previous year, or if the pandemic strain was brought across to France in US troop ships after 'taking off' in the crowded conditions of army recruit camps.

The 1918/19 H1N1 flu likely 'jumped' from birds to people (or via pigs), while the much less virulent 2009 H1N1 strain clearly originated in pigs to cause the first human pandemic of the 21st century. Mass air travel ensured that it was around the planet in six months.

The 2009 virus retains 1918 genes that were maintained for more than 90 years in pig populations. Way back in 1917/18, did pigs transmit the original H1N1 pandemic flu to us, or did we pass it to them? Either could be the case.

Similarly, the human immunodeficiency virus type 1 (HIV1), the most prominent cause of the human acquired immune deficiency syndrome (AIDS), is thought to have 'jumped' to humans back in the first half of the 20th century, perhaps when a hunter cut his hand while killing an infected chimpanzee (bush meat).

Then, as often occurs, HIV1 seemed to spread slowly between people until, in 1981, we saw the dramatic emergence of AIDS in New York and San Francisco.

Many and varied factors influence such disease incursions from other species, then 'breakouts' from small, localised events. Changes in social practices, patterns of international travel and the movement of humans (with increasing population size) into previously forested areas are obvious triggers.

### **It's not just humans**

We are not, of course, the only species that can suddenly acquire infections from other vertebrates.



Setting aside HIV/AIDS, which may be regarded as a 'continuing' (since 1981) pandemic, the worst pandemic of modern times was the 1918-19 Spanish flu that killed 40-50 million people globally.

Canine distemper virus (CDV) has, for instance, become established in Serengeti spotted hyenas.

Regular, fatal outbreaks in lions look to have come directly from dogs or perhaps other wildlife, including hyenas.

CDV is related to both bovine rinderpest virus (dubbed cattle plague) and human measles, both of which are closer to each other. Gene sequences suggest these two pathogens diverged about 1,000 years back, perhaps from an ancestral virus that is not identical to either.

### **Eradicating viruses with vaccinations**

Using vaccination and other disease control measures, we have eliminated two virus infections that have, through the ages, caused massive economic damage and loss of life: human smallpox (1980) and bovine rinderpest (2011).

Another scourge, polio, is close to eradication. But problems remain with vaccine coverage (and the safety

of the medical teams) in regions that are essentially war zones.

We could also eradicate measles, but this is hampered by some parents in the developed world who believe they do not have a responsibility to immunise their children against the standard infections of childhood.

The rinderpest eradication shows it's easier to eradicate viruses in domestic animals than people!

Veterinarians are also embarking on another global eradication program to get rid of the rinderpest-related PPR (*peste de petits ruminants*) that infects sheep and goats.

**Peter C Doherty** is Laureate Professor, The Peter Doherty Institute for Infection and Immunity.

## **THE CONVERSATION**

Doherty, PC (27 April 2016). *Disease evolution: our long history of fighting viruses*. Retrieved from <https://theconversation.com> on 15 September 2016.

# Disease evolution: how new illnesses emerge when we change how we live

In this piece from *The Conversation*, **Associate Professor Simon Reid** explains that the emergence of diseases is largely driven by changes in human societies

**H**umans have been ‘acquiring’ infectious diseases from animals (zoonotic diseases) since we first started hunting wild game on the African savannahs. Indeed, nearly 60% of bugs that infect humans originated in animals.

These days, we seem to see more ‘new’ diseases, such as Zika, Ebola and SARS. But there are plenty more lurking. A recent study suggests there are around 300,000 pathogens we don’t even know about and some have the potential to spread from animals to humans.

The world’s scientific community is focused on how to improve detection and responses to emerging diseases such as Zika virus and Ebola. So what can we learn from the most recent large-scale outbreaks?

*Nearly 60% of bugs that infect humans originated in animals.*

## Animal ‘spillover’

The three most common factors associated with the emergence of diseases are:

- Changes in land use for agricultural practices
- Changes in human demography, such as population growth and urbanisation
- Poor population health and health services.

These factors are often interlinked and can turn a small ‘spillover’ outbreak from animals into a major epidemic, as seen in the most recent Ebola epidemic.

Essentially, humans put themselves in harm’s way just by going about their daily business of growing or harvesting food and seeking shelter.

## Ebola

Ebola is caused by a virus thought to be carried in fruit bats that spills over into other mammals such as primates and antelope. Humans are infected when they hunt or butcher animals for food or consume uncooked fresh or dried bushmeat.

Human-to-human transmission involves close contact with bodily fluids. This often happens in health care settings and when people care for sick relatives or perform traditional burial practices that involve direct contact with bodies.

The 2014 outbreak in West Africa, which caused more than 28,000 infections and 11,000 deaths, was a sudden departure from the usual picture of small, localised outbreaks in remote areas because of a ‘perfect storm’ of factors.

The war-torn countries involved experienced a dramatic increase in population growth, high levels of urbanisation, increases in agricultural production



(especially livestock) and associated changes in land use and land clearing.

On top of that, they had very few health services (reportedly just 50 doctors in the whole of Liberia), especially in rural areas. This combined with the widespread consumption of bushmeat, traditional burial practices and rapid transport networks to drive the outbreak.

It's not hard to see why the spread from rural areas to cities occurred so rapidly; where else would people go for help?

## SARS

Severe acute respiratory syndrome (SARS) was the defining emerging disease of the 21st century. Caused by a highly infectious coronavirus, it was a global shock which demonstrated how quickly diseases can spread around the world.

The spread of SARS was greatly accelerated by geography. It was first detected in Guangdong Province in China but it spread from nearby Hong Kong via a vast network of international air travel.

The natural host of SARS is thought to be bats. But the jump to humans occurred via the palm civet, a small omnivorous mammal.

Civets are a delicacy and eating them is a sign of wealth in Cantonese culture. At the time, civets were slaughtered for local consumption at restaurants specialising in wild game. One of the first cases was a cook in Shenzhen.

The live animal markets bring together a bewildering array of animal species and are critical junctures between rural and urban communities. This is where one-third of cases originated.

## Zika virus

Zika virus is the latest emerging disease to hit the news. It was first isolated from a rhesus monkey in the Zika forest of Uganda in 1947 by scientists studying the closely related yellow fever virus.

Like its relative the dengue virus, Zika's usual cycle of mosquito-monkey-mosquito expanded to include humans when we entered their ecological niche to collect food or for shelter.

The human disease caused by Zika had remained largely invisible since its first identification in 1954. Its recent 'emergence' may just be a response to its higher profile after the discovery that infection during pregnancy is associated with the birth defect microcephaly, which causes babies to be born with unusually small heads.

Zika virus will continue to quietly spread around the world via air travel and establish in more countries because its mosquito carrier, *Aedes aegypti*, is present in more than 128 countries including parts of Europe, the United States and Australia.

## Why did these diseases jump species?

The common theme in the spillover of each of these viruses is food; they are a consequence of the human

need for protein.

Once the viruses make the species jump, their severity is a major factor in what happens next. It is easier for a mild disease such as Zika to spread unnoticed in a population because it is unlikely to lead a person to seek medical attention.

When disease is severe (think rapid hospitalisation and death), such as Ebola or SARS, it tends to make itself known more rapidly, triggering an aggressive public health response that can lead to suppression of the outbreak.

*These days, we seem to see more 'new' diseases, such as Zika, Ebola and SARS. But there are plenty more lurking. A recent study suggests there are around 300,000 pathogens we don't even know about and some have the potential to spread from animals to humans.*

The rapid spread of SARS by international air travel to wealthy countries with effective public health systems was a major factor in its limited duration compared with Ebola, which largely remained in a limited geographic range. Ebola may well have become a global pandemic if it had occurred in a major international transport hub.

## Preventing disease outbreaks

The world will not prevent the next global pandemic using 'business as usual' thinking. We need to acknowledge we live in a rapidly converging world where solutions cross all sectors of society.

Major cross-sectoral initiatives, such as the US government's Emerging Pandemic Threats program, are making some progress. This program attempts to create national, regional and global 'One Health' networks to reduce the risk of disease emergence and improve our ability to detect and respond to these unpredictable beasts.

But this is not enough because the emergence of diseases is largely driven by changes in human societies. The only thing that will change the drivers of disease is a fundamental rethink about how we co-exist with our environment.

Unfortunately, there are no easy answers to how we build and feed a global community of 9 billion and not cause an emerging disease disaster along the way.

**Simon Reid** is Associate Professor of Communicable Disease Control, The University of Queensland.

## THE CONVERSATION

Reid, S (29 April 2016). *Disease evolution: how new illnesses emerge when we change how we live*. Retrieved from <https://theconversation.com> on 15 September 2016.

# REMIND ME AGAIN, HOW CLOSE ARE WE TO A CURE FOR HIV?

Simplicity of delivery will be critical if a 'cure' is going to be deliverable in the parts of the world where HIV is endemic, writes **Bridget Haire**

**F**inding a cure for HIV is a powerful concept, often spoken of as the Holy Grail of HIV research. Although effective anti-HIV drugs have transformed HIV into a chronic manageable condition – a condition you live with, rather than die from – taking life-long therapy is a very different proposition to being definitively cured.

An affordable, scalable HIV cure that worked as well in rural Malawi as in urban Sydney would put the global eradication of new HIV infections within reach, while also transforming the lives of those now living with the virus. This must be the goal of cure research: to prioritise interventions that have potential application worldwide, not limited to settings with highly developed health systems.

Research into a cure for HIV has been gathering momentum. Global investment in cure research has more than doubled in the last four years, in contrast with investment in other HIV programs.

Given the effectiveness of antiretroviral drugs in both treating and preventing HIV infection, however, cure research raises a range of important questions about priority setting in global health.

Curing HIV – or at least achieving long-term remission – is possible, under the right circumstances.

## Bone marrow transplants

In 2007, Timothy Rae Brown, formerly known as 'the Berlin patient', required a bone marrow transplant to treat his leukaemia. Brown also had HIV, and his doctor suggested that if they could find a bone marrow match from a donor who had rare genetic mutation on the CCR5 receptors – receptors that HIV uses to get inside cells – this could potentially cure Brown of HIV.

The immune cells that HIV infects are made in the bone marrow. So transplanting bone marrow using a donor who lacks HIV receptors means that the new bone marrow would produce immune cells that were resistant to HIV infection.

A matching donor with the CCR5 mutations was found, the harrowing transplant was performed, and it was successful. Brown was able to cease antiretroviral therapy, and has not had a viral rebound since (though his leukaemia did relapse and he required a second transplant).

While it is unknown whether HIV has been completely eradicated from his body, in 2016 Brown still has no detectable HIV in his blood, and does not require antiretroviral drugs.

While Brown's case demonstrates HIV can be forced into remission, it has not resulted in a reproducible form of cure. Bone marrow transplants are themselves life-threatening and extremely resource-intensive. It would be highly unethical to transplant bone marrow in a person who did not require this for another serious illness such as leukaemia.

The particular CCR5 mutations required is and generally only found in Northern Europe, where an estimated 1% has one copy of this genetic variation. Even fewer have the two copies that are required for high-level resistance to HIV infection.

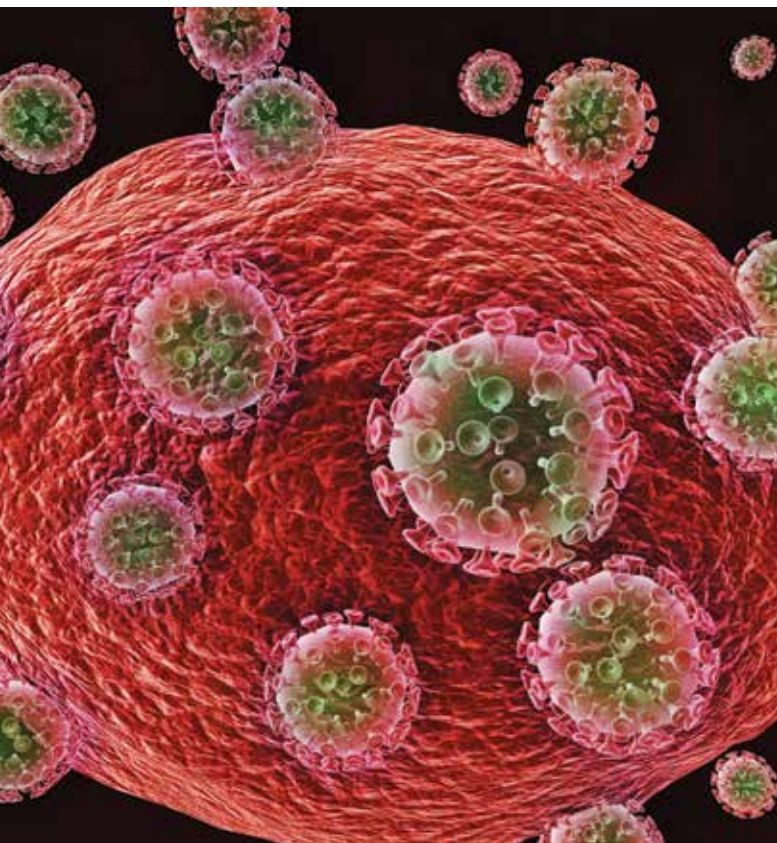
## Shock and kill

Current approaches to cure research are focused on achieving a 'functional cure' or remission of HIV rather than a sterilising cure, which would aim at removing all traces of HIV from the body.

HIV integrates with the body's DNA early in infection. It then 'hides' in hard-to-reach immune compartments where cells turn over very slowly. So finding ways of flushing HIV out of the places where it lies dormant is an important aspect of cure research.

This approach is often called the 'shock and kill'. It uses latency-reversing agents (chemotherapy-like drugs) to activate cells that have been latently infected with HIV and then kill the HIV.

If a safe, limited dose combination of drugs could



# AIDS and HIV in Australia

- AIDS is the syndrome caused by damage to the body's immune system that results from HIV. AIDS is an advanced stage of HIV infection, occurring when the body no longer has capacity to fight off infections and other illnesses.
- In July 2016, leading scientists at the Kirby and Peter Doherty institutes and the Australian Federation of AIDS Organisations announced that AIDS is no longer a public health problem in Australia – a major achievement.
- Given widespread use of antiretroviral treatment (ART) in Australia, cases of AIDS are so few that they are no longer recorded on public health registers.
- Modern ART is so effective at suppressing HIV within a person's body, that people consistently using ART are unlikely to ever develop AIDS.
- Estimates indicate that 73% of Australians living with HIV are currently using ART.
- Since 1982, more than 35,000 Australians have been diagnosed with HIV and around 10,000 have died from AIDS-related illnesses.
- At the epidemic's peak in the mid-1990s, there were close to 1,000 new diagnoses of AIDS each year – the majority among men in their 20s and 30s.
- HIV is very much an important public health issue in this country – there are currently over 27,000 people living with HIV in Australia; 1,000 new cases are diagnosed each year.
- People living with HIV still require specialised clinical and support services, especially as people age and need to manage HIV alongside other chronic conditions.
- The majority of new HIV infections still occur among men who have sex with men, but new diagnoses are increasing among Indigenous Australians, migrant communities and mobile populations such as transient workers.
- HIV, unlike most other chronic illnesses, is still subject to widespread stigma, discrimination and misunderstanding.
- Most Australians who contract HIV today will never get AIDS. If people have an undetectable amount of HIV in their system, which is often the case among people using ART, they have almost zero chance of transmitting HIV to others.
- AIDS is still a major public health problem in other countries – globally, more than 35 million people live with HIV, most of whom live in countries where ART is not readily available or affordable. In 2014 alone, more than 1.2 million people died from AIDS-related illnesses.

Source: Power, J (12 July 2016), 'AIDS epidemic no longer a public health issue, but HIV still is', *The Conversation*.

be developed, this approach could prove potentially deliverable in disparate settings globally.

## Immune-based therapies

Another approach is bolstering the human immune system to control HIV replication without antiretroviral drugs using therapeutic vaccines and antibody-based therapeutics.

If a therapeutic vaccine was developed that controlled HIV replication without antiretroviral drugs and required limited dosing (ideally one-off dosing), this would be an improvement on the current need to take medication daily to control HIV.

## Treating newborns

A third area of investigation is early intensive antiretroviral therapy for newborns. This strategy relies on intensive use of antiretroviral drug in infants who acquired HIV from their mothers.

Particular properties of the developing infant immune system make such an approach more likely to work in newborns than in adults. There is a documented case of a child who controlled HIV successfully for 27 months following cessation of treatment (known as the Mississippi baby).

## Gene editing

Finally there are cell-based therapies: genetic modification or 'gene editing' in people with HIV, including

stem-cell transplantation.

While these have the advantage of being one-off intervention, they carry the serious disadvantage of being extremely intensive in the use of medical technology and potentially risky to patients.

As antiretroviral treatment for HIV is now highly effective and relatively simple (often just a pill a day), approaches to a potential HIV cure need to be evaluated according to whether they might offer a real advantage over lifelong therapy at both individual and population levels.

Evaluating the social value of particular cure strategies is a critical aspect of ensuring that the right kinds of research are prioritised – those that have the potential to transform the epidemic in resource poor contexts. Simplicity of delivery will be critical if an intervention is going to be deliverable in the parts of the world where HIV is endemic.

**Bridget Haire** is Lecturer in ethics, HIV prevention, UNSW Australia.

## THE CONVERSATION

Haire, B (19 July 2016). *Remind me again, how close are we to a cure for HIV?* Retrieved from <https://theconversation.com> on 15 September 2016.

# KNOW YOUR BUGS – A CLOSER LOOK AT VIRUSES, BACTERIA AND PARASITES

**Arinjay Banerjee, Jason Byron Perez and Simona John von Freyend** explain the difference between these pathogens, and the dangers they present

**S**top the spread of superbugs,” “15 superbugs and other scary diseases” and “Superbug bacteria found in tested hotel rooms” are headlines we often read or hear about. But what do we mean when we say “bugs”?

The term is used to describe viruses, bacteria and parasites. While they can all make us sick, they do it in different ways. So what is the difference between these pathogens, and how dangerous are they?

Let’s start with viruses, the smallest of the three.

## Viruses – from the common cold to Ebola

Viruses have been around for a really, really long time. They predate us and could even be our oldest ancestors.

Viruses have helped build genomes of all species, including humans. Our genome is made up of 50 per cent retroelements – the DNA from retroviruses. And viruses might have paved the way for several DNA replication enzymes, which are essential for a cell to divide and grow.

Viruses are capable of causing infections in humans and animals – and some viruses can even jump from one to the other.

Viruses have two phases of life. Outside a cell, they are non-living and are called virion particles. Once inside a cell they use the cellular machinery to their advantage to replicate and multiply. Some scientists may argue that viruses are alive when inside a cell.

Some viruses, like the common cold, can make us sick, but don’t do lasting harm. But others are known to cause lethal disease in humans and animals. A pandemic strain of influenza can severely infect a large number of people in a very short time. There were an estimated

201,200 respiratory deaths with an additional 83,300 cardiovascular deaths globally during the 2009 influenza (H1N1) pandemic.

While we are exposed to virus particles every day, we don’t always fall sick because the immune system can handle most of them. We get sick when we encounter a new virus for the first time or in sufficient quantity. This is why it is recommended to get a flu shot every year. The circulating strain of influenza may vary each year, and immunity from a previous infection or vaccine might not protect us in the event of exposure to a different strain.

The ability to spread quickly and replicate rapidly makes some of these viruses dreaded entries on the list of pathogens, to an extent that some are even considered as potential weapons of mass destruction. There are also viruses that kill slowly over time. A classic example is the rabies virus. It has a long incubation period (1-3 months) and is vaccine-preventable, but once the symptoms set in, the individual is almost certain to die.

Vaccines are the best way to protect ourselves from viruses. Vaccines prime the immune response, allowing our bodies to respond to an actual infection more efficiently. Vaccines have reduced the disease burden for several otherwise lethal viruses such as measles, rubella, influenza and smallpox. Beyond that, washing hands and covering noses while sneezing are practices that can keep some of these viruses at bay.

## Bacteria – toxin-producing invaders

Some bacteria are good for you, offering protection against pathogens and aiding with digestion in the gut. But some aren’t so beneficial

or benign.

Some are specialised to cause disease such as Staphylococcal infection (*Staphylococcus aureus*), botulism (*Clostridium botulinum*), gonorrhea (*Neisseria gonorrhoeae*), gastric ulcer (*Helicobacter pylori*), diphtheria (*Corynebacterium diphtheriae*) and bubonic plague (*Yersinia pestis*).

They can produce toxins, invade cells or the bloodstream, or compete with the host for shared nutrients – all of which can lead to illness. The right course of treatment can depend on how the bacteria is causing illness.

Take botulism, for instance. People get it when they eat food contaminated with toxins or bacterial spores from *C. botulinum*. If a person ingests the toxin, he or she can develop symptoms within six to 36 hours. If the spore is ingested, it can take up to a week.

Supportive care is the primary therapeutic method, to prevent or relieve other possible complications and to maintain the health and breathing of the patient. Antibiotics treat infections by destroying the bacterium, but with botulism, the destruction of the bacterium can lead to the release of more toxins, causing severe illness. Doctors treat toxins by administering antitoxins or inducing vomiting.

Today, thanks to the misuse and overuse of antibiotics, resistant bacteria is on the rise, and as of 2013, there were about 480,000 new cases of multidrug-resistant tuberculosis (MDR-TB).

Cycling between different antibiotics can reduce the risk of resistance. Alternatives, such as bacteriophages (bacteria killing viruses) or enzymes that destroy the genome of resistant bacteria, are being developed. In fact, bacteriophages are widely used in Eastern Europe but haven’t been approved in North America.

There are vaccines available for some bacteria, like the DPT vaccine against Diphtheria, *Bordetella pertussis* and *Clostridium tetani*. And there are plenty of simple solutions to prevent bacteria from making us sick, such as proper hand washing, disinfection of surfaces, use of clean water and cooking to appropriate temperatures to eliminate bacteria.

## Parasites – benefiting at our expense

The third group in our trio of pathogens – parasites – have inspired many horror stories and many of us find them kind of gross.

Parasites are a diverse group of organisms that live in or on a host (like us) and benefit at the host's expense. Parasites can be microscopic single cellular organisms called protozoa, or bigger organisms like worms or ticks. Protozoan parasites are actually more closely related to the cells in our body than to bacteria.

Parasites are everywhere, and they can play a complex and important role in ecosystems.

But parasites can also cause horrendous diseases, especially in the developing world. In many cases, infection with parasites goes hand in hand with bad sanitary conditions and poverty. Even though much progress has been made, malaria, which kills one child every 30 seconds with 90 per cent of the cases in Africa, is still the most deadly disease caused by parasites. But it is by far not the only one.

Other parasitic diseases common in many – mostly tropical – parts of the world are Leishmaniasis, River Blindness and Elephantiasis.

Many parasites are transmitted by mosquitoes and other insects, and with the effects of climate change intensifying, many parasitic diseases are likely to move farther north.

Parasitic diseases are on the rise in developed countries, including the US Chagas disease, for example, is caused by a single cellular parasite and cases are increasing in North America, possibly aided by climate change.



Getting a harmful virus, bacterial infection or parasite disease isn't good news. Fortunately we have effective treatments for some of them, and vaccines that can prevent us from getting sick as well, even if some of these bugs can evade the best medicines we have.

There are no vaccines available so far against any major parasitic diseases in humans, but there is plenty of research on that front. Luckily, there are many drugs available to combat parasites.

For instance, the 2015 Nobel Prize in Medicine was given to scientists who developed antiparasitic drugs (one drug, Ivermectin, treats worms; the other, Artemisinin, treats malaria). These two drugs have helped whole countries to manage scourges caused by parasitic worms and malaria.

The latest success was in September 2015, when Mexico eliminated River Blindness, which is caused by *Onchocerca volvulus*, with the help of ivermectin donated by Merck.

## Stay clean

Getting a harmful virus, bacterial infection or parasite disease isn't good news. Fortunately we have effective treatments for some of them, and vaccines that can prevent us from getting sick as well, even if some of these bugs can evade the

best medicines we have.

And keep in mind that even if these bugs can make us very, very sick, you still need to be exposed to them to become infected. While bigger strategies, like sanitation and infection control can keep us and others safe, so can simple strategies, like washing our hands, staying home when we are sick and covering our mouths when we cough or sneeze.

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## THE CONVERSATION

Banerjee, A, Perez, JB and von Freyend, SJ (31 March 2016). *Know your bugs – a closer look at viruses, bacteria and parasites*. Retrieved from <https://theconversation.com> on 13 September 2016.

# ANTIMICROBIAL RESISTANCE

## FACT SHEET FROM THE WORLD HEALTH ORGANIZATION

### Key facts

- Antimicrobial resistance (AMR) threatens the effective prevention and treatment of an ever-increasing range of infections caused by bacteria, parasites, viruses and fungi.
- AMR is an increasingly serious threat to global public health that requires action across all government sectors and society.
- Without effective antibiotics, the success of major surgery and cancer chemotherapy would be compromised.
- The cost of health care for patients with resistant infections is higher than care for patients with non-resistant infections due to longer duration of illness, additional tests and use of more expensive drugs.
- Globally, 480,000 people develop multi-drug resistant TB each year, and drug resistance is starting to complicate the fight against HIV and malaria, as well.

### What is antimicrobial resistance?

**A**ntimicrobial resistance happens when microorganisms (such as bacteria, fungi, viruses, and parasites) change when they are exposed to antimicrobial drugs (such as antibiotics, antifungals, antivirals, antimalarials, and anthelmintics). Microorganisms that develop antimicrobial resistance are sometimes referred to as 'superbugs'.

As a result, the medicines become ineffective and infections persist in the body, increasing the risk of spread to others.

### Why is antimicrobial resistance a global concern?

New resistance mechanisms are emerging and spreading globally, threatening our ability to treat common infectious diseases, resulting in prolonged illness, disability, and death.

Without effective antimicrobials for prevention and treatment of infections, medical procedures such as organ transplantation, cancer chemotherapy, diabetes management and major surgery (for example, caesarean sections or hip replacements) become very high risk.

Antimicrobial resistance increases the cost of health care with lengthier stays in hospitals and more intensive care required.

Antimicrobial resistance is putting the gains of the Millennium Development Goals at risk and endangers achievement of the Sustainable Development Goals.

### What accelerates the emergence and spread of antimicrobial resistance?

Antimicrobial resistance occurs naturally over time, usually through genetic changes. However, the misuse and overuse of antimicrobials is accelerating this process.

In many places, antibiotics are overused and misused in people and animals, and often given without professional oversight. Examples of misuse include when they are taken by people with viral infections like colds and flu, and when they are given as growth promoters in animals and fish.

Antimicrobial resistant microbes are found in people, animals, food, and the environment (in water, soil and air). They can spread between people and animals, and from person to person. Poor infection control, inadequate sanitary conditions and inappropriate food-handling encourage the spread of antimicrobial resistance.

### Present situation

#### *Resistance in bacteria*

Antibiotic resistance is present in every country.

Patients with infections caused by drug-resistant bacteria are at increased risk of worse clinical outcomes and death, and consume more health care resources than patients infected with non-resistant strains of the same bacteria.

*New resistance mechanisms are emerging and spreading globally, threatening our ability to treat common infectious diseases, resulting in prolonged illness, disability, and death.*

Resistance in *Klebsiella pneumoniae* – common intestinal bacteria that can cause life-threatening infections – to a last resort treatment (carbapenem antibiotics) has spread to all regions of the world. *K. pneumoniae* is a major cause of hospital-acquired infections such as pneumonia, bloodstream infections, and infections in newborns and intensive-care unit patients. In some countries, because of resistance, carbapenem antibiotics do not work in more than half of people treated for *K. pneumoniae* infections.

Resistance in *E. coli* to one of the most widely used medicines for the treatment of urinary tract infections (fluoroquinolone antibiotics) is very widespread. There are countries in many parts of the world where this treatment is now ineffective in more than half of patients.

Treatment failure to the last resort of medicine for gonorrhoea (third generation cephalosporin antibiotics) has been confirmed in at least 10 countries (Australia, Austria, Canada, France, Japan, Norway, Slovenia, South Africa, Sweden and the United Kingdom of Great Britain and Northern Ireland).

WHO recently updated the treatment guidelines for gonorrhoea to address emerging resistance. The

new WHO guidelines do not recommend quinolones (a class of antibiotic) for the treatment of gonorrhoea due to widespread high levels of resistance. In addition, treatment guidelines for chlamydial infections and syphilis were also updated.

Resistance to first-line drugs to treat infections caused by *Staphylococcus aureus* – a common cause of severe infections in health facilities and the community – is widespread. People with MRSA (methicillin-resistant *Staphylococcus aureus*) are estimated to be 64% more likely to die than people with a non-resistant form of the infection.

Colistin is the last resort treatment for life-threatening infections caused by *Enterobacteriaceae* which are resistant to carbapenems. Resistance to colistin has recently been detected in several countries and regions, making infections caused by such bacteria untreatable.

### **Resistance in tuberculosis (TB)**

WHO estimates that, in 2014, there were about 480,000 new cases of multidrug-resistant tuberculosis (MDR-TB), a form of tuberculosis that is resistant to the two most powerful anti-TB drugs. Only about a quarter of these (123,000 cases) were detected and reported. MDR-TB requires treatment courses that are much longer and less effective than those for non-resistant TB. Globally, only half of MDR-TB patients were successfully treated in 2014.

Among new TB cases in 2014, an estimated 3.3% were multidrug-resistant. The proportion is higher among people previously treated for TB, at 20%.

Extensively drug-resistant tuberculosis (XDR-TB), a form of tuberculosis that is resistant to at least four of the core anti-TB drugs, has been identified in 105 countries. An estimated 9.7% of people with MDR-TB have XDR-TB.

### **Resistance in malaria**

As of July 2016, resistance to the first-line treatment for *P. falciparum* malaria (artemisinin-based combination therapies, also known as ACTs) has been confirmed in 5 countries of the Greater Mekong subregion (Cambodia, the Lao People's Democratic Republic, Myanmar, Thailand and Viet Nam). In most places, patients with artemisinin-resistant infections recover fully after treatment, provided that they are treated with an ACT containing an effective partner drug. However, along the Cambodia-Thailand border, *P. falciparum* has become resistant to almost all available antimalarial medicines, making treatment more challenging and requiring close monitoring.

There is a real risk that multidrug resistance will soon emerge in other parts of the subregion as well. The spread of resistant strains to other parts of the world could pose a major public health challenge and jeopardise important recent gains in malaria control.

A 'WHO Strategy for Malaria Elimination in the Greater Mekong subregion (2015-2030)' was endorsed by all five countries, as well as China.

### **Resistance in HIV**

In 2010, an estimated 7% of people starting antiretroviral therapy (ART) in developing countries had drug-resistant HIV. In developed countries, the same figure was 10-20%. Some countries have recently reported levels at or above 15% amongst those starting HIV treatment, and up to 40% among people re-starting treatment. This requires urgent attention.

*Antimicrobial resistance is a complex problem that affects all of society and is driven by many interconnected factors ... coordinated action is required to minimise the emergence and spread of antimicrobial resistance.*

Increasing levels of resistance have important economic implications as second- and third-line regimens are 3 times and 18 times more expensive, respectively, than first-line drugs.

Since September 2015, WHO has recommended that everyone living with HIV start on antiretroviral treatment. Greater use of ART is expected to further increase ART resistance in all regions of the world. To maximise the long-term effectiveness of first-line ART regimens, and to ensure that people are taking the most effective regimen, it is essential to continue monitoring resistance and to minimise its further emergence and spread. In consultation with countries, partners and stakeholders, WHO is currently developing a new 'Global Action Plan for HIV Drug Resistance (2017-2021)'.



## Superbugs could kill 10 million a year by 2050

- Superbugs are strong strands of bacteria that often cause common gut, urinary and blood infections, but become dangerous because they're immune to the antibiotics we currently take.
- Some infections will become incurable unless new antibiotics are created.
- Currently there are 700,000 deaths from superbugs every year.
- A widespread use of antibiotics has contributed to the growth of superbugs; it is estimated that about 50 per cent of the time, antibiotics are not prescribed properly and sometimes consumed when our bodies do not even need them.
- An 18-month review commissioned by the UK government into antimicrobial resistance (released May 2016) warns that superbugs will kill more people by 2050 than cancer does in 2016, if left unchecked.
- Asia and Africa are most at risk among all of the continents. By 2050, more than 4.7 million will die from superbugs each year in Asia, 4.1 million in Africa, 392,000 in South America, 390,000 in Europe, 317,000 in North America and 22,000 in Oceania, according to the report.
- Against the potential US\$100 trillion (\$138 trillion) annual cost of health care caused by spreading superbugs, the review team had proposed a global, AUD\$55 billion program to protect the remaining effective antibiotics, and to discover new ones.
- The report into superbugs suggests we need to reduce the demand for antibiotics, improve hygiene and prevent the spread of infection.
- Doctors should be encouraged to use diagnostic tests to first prove that a patient genuinely needed an antibiotic, before prescribing it.
- The report also proposes a global agreement to dramatically reduce the amount of antibiotics used in agriculture by 2018, as well as an outright ban on the agricultural use of specific antibiotics that are vital to human health, such as colistin.

Source: Review on Antimicrobial Resistance website, 19 May 2016.

### Resistance in influenza

Antiviral drugs are important for treatment of epidemic and pandemic influenza. So far, virtually all influenza A viruses circulating in humans were resistant to one category of antiviral drugs – M2 inhibitors (amantadine and rimantadine). However, the frequency of resistance to the neuraminidase inhibitor oseltamivir remains low (1-2%). Antiviral susceptibility is constantly monitored through the WHO Global Influenza Surveillance and Response System.

### Need for coordinated action

Antimicrobial resistance is a complex problem that affects all of society and is driven by many interconnected factors. Single, isolated interventions have limited impact. Coordinated action is required to minimise the emergence and spread of antimicrobial resistance.

All countries need national action plans on AMR.

Greater innovation and investment are required in research and development of new antimicrobial medicines, vaccines, and diagnostic tools.

### WHO's response

WHO is providing technical assistance to help countries develop their national action plans, and strengthen their health and surveillance systems so that they can prevent and manage antimicrobial resistance. It is collaborating with partners to strengthen the evidence base and develop new responses to this global threat.

WHO is working closely with the Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (OIE) in a 'One Health' approach to promote best practices to avoid the emergence and spread of antibacterial resistance, including optimal use of antibiotics in both

humans and animals.

A global action plan on antimicrobial resistance was adopted by Member States at the Sixty-eighth World Health Assembly and supported by the governing bodies of FAO and OIE in May and June 2015. The goal of the global action plan is to ensure, for as long as possible, continuity of successful treatment and prevention of infectious diseases with effective and safe medicines that are quality-assured, used in a responsible way, and accessible to all who need them.

A high-level meeting on antimicrobial resistance at the United Nations General Assembly will be held on 21 September 2016 to accelerate global commitments and enhance national multi-sectoral efforts to combat antimicrobial resistance.

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World Health Organization (September 2016). *Antimicrobial resistance* (Fact sheet). Retrieved from [www.who.int](http://www.who.int) on 19 September 2016.

# ANTIBIOTIC RESISTANCE: THE FACTS

*Overuse and misuse of antibiotics is increasing the problem of antibiotic resistance. We are all part of the problem and the solution, according to this fact sheet from **NPS MedicineWise***

The following facts bust some common misconceptions about antibiotic use and antibiotic resistance.

**FACT: Antibiotics don't work for all infections**

Antibiotics only work on bacteria, not other infections like viruses that cause colds and flu. Taking an antibiotic when it's not needed will not make a significant difference to how you feel or how fast you recover. When you start to feel better it's usually because your immune system is doing the work to treat your infection.

**FACT: It is bacteria that become resistant to antibiotics, not your body**

Antibiotic resistance happens when bacteria change or mutate to protect themselves from an antibiotic. The more antibiotics are used or not taken correctly, the more chance bacteria have to change and become resistant to them. This can then make bacterial infections much harder to treat. Mutated bacteria can also pass their genes to other bacteria, forming a new antibiotic resistant 'strain' of the bacteria.

**FACT: Antibiotic resistance is already impacting our health – and the problem is getting worse**

Antibiotic-resistant infections are not just seen in hospitals, agriculture and countries overseas, or a problem to deal with in the future. Antibiotic resistance is already affecting individuals in the Australian community.

Infection with antibiotic-resistant bacteria is associated with longer stays in hospital and a higher death rate. In Australia, the prevalence of multi-resistant bacteria (also known as 'superbugs') is increasing, and the number of patients with staph infections that are resistant to multiple antibiotics is rising.

If you have an infection that is

caused by bacteria which is resistant to antibiotics you are more likely to die from that infection. Examples of bacteria in the community that have already developed resistance to a number of antibiotics include strains of *Escherichia coli* (E. coli) that cause many urinary tract infections. 'Golden staph', a common cause of skin infections, is another example. Failure of the last-resort antibiotic treatment for the sexually transmitted infection gonorrhoea has even occurred in Australia.

**FACT: Green snot doesn't mean you need antibiotics**

Coloured mucous or phlegm isn't always a sign of a bacterial infection, and that also goes for other symptoms including cough, sore throat, earaches and fever. While some people with these symptoms will need antibiotics, most people won't and will get better without antibiotics. Green or yellow coloured snot can in fact be a sign that your

immune system is fighting your infection, and not that your illness is getting worse.

**FACT: Sharing antibiotics and using leftovers can increase antibiotic resistance**

When bacteria encounter an antibiotic, they adapt to protect themselves.

There are actions that you can take to reduce the chance of resistance developing.

Take the prescribed dose and complete the whole course of treatment prescribed by your doctor – even if you are feeling better, this reduces the chance that some bacteria will survive and become resistant. Don't share antibiotics with another person or keep leftovers. This is important because the type of antibiotic may not be targeted to the bacteria causing that particular infection, and the dose and amount leftover may not be enough to destroy it – creating more

Antibiotics only work on bacteria, not other infections like viruses that cause colds and flu. Taking an antibiotic when it's not needed will not make a significant difference to how you feel or how fast you recover.





Antibiotic resistance happens when bacteria change or mutate to protect themselves from an antibiotic.

opportunity for resistant bacteria to develop and multiply.

**FACT: Antibiotic resistance can have personal consequences for you, your family and the community**

If you or a member of your family develop an antibiotic-resistant infection, you will have the infection for longer, you may be more likely to have complications from the infection, you could remain infectious for longer and pass your infection to other people. Antibiotic resistant bacteria can persist in your body for as long as 12 months and be passed on to family members or others in the community.

**FACT: The drug pipeline for antibiotics is drying up**

In the last 50 years only one antibiotic that works in a novel way has been discovered and developed for use in humans.

In 2015, media reported the discovery of a new class of antibiotics, called teixobactin, as a “break-through” and a “game-changer”. However the new antibiotic has not yet even been tested in people. So far it has only been shown to be toxic to

bacteria in mice. It will likely be years before it becomes a viable option in humans. This new antibiotic only works on certain types of bacteria (gram-positive) – so it would help for some of the currently hard-to-treat infections, but not all. For example, it is not effective against *E. coli* (as that is gram-negative) which can be resistant to antibiotics.

The time it is taking for bacteria to become resistant to new antibiotics is getting shorter, so even if new antibiotics are discovered, this will likely become an issue again if we don’t change the way we use antibiotics.

**FACT: Patient and doctor misconceptions contribute to the problem**

Reducing antibiotic resistance is everyone’s responsibility.

Research by NPS MedicineWise shows that patient expectations lead many general practitioners to prescribe antibiotics when they may not be effective – contributing to the growing problem of antibiotic resistance.

The 2014 research indicates that more than half of GPs (57%) reported that they would prescribe antibiotics for an upper respiratory

tract infection to meet patient expectations – and 20% of surveyed consumers said they would expect the doctor to prescribe antibiotics for a cold or flu, while 17% would ask a doctor to prescribe antibiotics.

Some doctors don’t believe their individual prescribing makes a difference, and some patients believe antibiotic resistance is an issue for future generations and therefore they won’t bear the consequences.

The reality is that antibiotic resistance is already impacting individuals and is a growing problem in our community. We all need to take personal action to preserve antibiotics.

**FACT: What you do as individuals can have a very real impact on antibiotic resistance**

There is a misconception that this is a problem we have no control over, and therefore action at an individual level makes no difference. Actually, the more antibiotics are used, the more chances bacteria have to become resistant to them. This can then make bacterial infections much harder to treat.

There are five things you can pledge to do to reduce antibiotic resistance:

1. I will not ask for antibiotics for colds and the flu as they have no effect on viruses
2. I understand that antibiotics will not help me recover faster from a viral infection
3. I will only take antibiotics in the way they have been prescribed
4. I understand that it is possible to pass on antibiotic resistant bacteria to others
5. I will make a greater effort to prevent the spread of germs by practising good hygiene.

**To take the pledge to fight antibiotic resistance, go to [www.nps.org.au/jointhefight](http://www.nps.org.au/jointhefight)**

NPS MedicineWise (2016). *Antibiotic resistance: The facts*. Retrieved from [www.nps.org.au](http://www.nps.org.au) on 13 September 2016.

# When the drugs don't work: how we can turn the tide of antimicrobial resistance

**ROISIN MCMAHON AND MAURIZIO LABBATE** EXPLAIN THE LATEST FINDINGS ON THE GROWTH OF BACTERIAL RESISTANCE TO ANTIBIOTICS

A new report by the Australian Academy of Science has called for the Australian government to take immediate action to counter the growing resistance of bacteria to antibiotics, a problem known as antimicrobial resistance. The paper particularly highlights addressing shortfalls in research funding, food labelling and collaborations between sectors.

Antimicrobials are drugs that treat infections caused by microorganisms (bacteria, viruses and fungi). Antimicrobial resistance occurs when microorganisms evolve to survive exposure to antimicrobials. This could mean a course of antibiotics you take for a bacterial infection is ineffective.

Antimicrobial resistance is accelerated when antimicrobials are used unnecessarily, such as when antibiotics are prescribed for a viral infection, or used as growth promoters in farming practices, and when their use is poorly managed.

## WHAT WILL HAPPEN AS THE DRUGS STOP WORKING?

In January of this year a woman died in the US from a bacterial infection following a hip break. She developed an infection that was resistant to all known antibiotics and was untreatable. This is just one example of what a world of unrestrained antimicrobial resistance might look like. Without action, the loss of effective antimicrobials is anticipated to claim ten million lives a year by 2050 and cost US\$100 trillion (A\$132tr).

Without antimicrobials we risk a return to death from infections previously thought defeated. We will likely also be unable to safely perform routine medical procedures such as hip replacements and Caesarean sections, or administer chemotherapy to cancer patients, as each often rely on accompanying antibiotics to prevent or treat infections.

## WHAT'S THE SOLUTION?

Antimicrobial resistance is a complex problem involving different sectors. It is driven by, and affects, the human, animal and environmental health sectors.

Within human, animal and environmental health, groups of prescribers, users and regulators have influence over antimicrobial use and resistance. We often think of prescribers as GPs, but within this group are all doctors, dentists, pharmacists, vets and nurse practitioners working in the community, in hospitals and in residential aged care facilities.

Similarly, patients are not the only users of antimicrobials. Farmers and pet owners also fall into this category. Local and national governments typically play the role of regulating antimicrobials, but as antimicrobial



Action to combat antimicrobial resistance requires prescribers, users and regulators of antimicrobials in human, animal and environmental health work together. This is because no single action in any single group is sufficient. This also makes it a very challenging solution to deliver.

resistance is a global problem, the actions of international governments and agencies are also significant.

Action to combat antimicrobial resistance requires prescribers, users and regulators of antimicrobials in human, animal and environmental health work together. This is because no single action in any single group is sufficient. This also makes it a very challenging solution to deliver.

Much has been written by governments and health organisations about how to respond to antimicrobial resistance. Common messages are that we need to reduce the use of current antimicrobials in order to preserve them. This includes preventing and reducing infections via vaccination, sanitation and good hygiene; developing new antimicrobials to replace ineffective ones; improving education about antimicrobial resistance; and expanding surveillance of resistant infections and antimicrobial usage so we understand the nature of the problem.

## REPORT RECOMMENDATIONS

The Australian government has outlined similar objectives in its First National Antimicrobial Resistance Strategy (2015-2019). The Australian Academy of Science Think Tank report sought concrete steps to accelerate one or more of these goals, and to consider important areas often overlooked. The report's recommendations include:

### **1. Fund interdisciplinary research in antimicrobial resistance**

Current barriers to research among different disciplines, including the fact research collaborations between sectors are less likely to get funding grants, need to be removed.

### **2. Create a national agency to coordinate changes in antimicrobial use and demand**

Programs to combat antimicrobial resistance must be consistent across states and territories. This requires unified oversight from a central body.

### **3. Clarify the role of human and animal waste in antimicrobial resistance**

There is much uncertainty about how environmental pollution contributes to the emergence of resistant microorganisms, its effect on both food and water security, and the effectiveness of antimicrobials in the clinic.

### **4. Label antibiotic use in food production**

Labelling how antimicrobials are used (for reasons other than animal health) educates consumers about the use of antimicrobials outside of medicine, and empowers consumers to make informed decisions.

Untreatable infections will continue to increase, affecting the most vulnerable first. These recommendations support the Australian government strategy and will help buy us vital time to identify and deliver solutions to antimicrobial resistance.

The full report 'An Interdisciplinary Approach to Living in a Risky World' and a complete list of its authors can be found at [www.science.org.au/files/userfiles/events/documents/think-tank-risk-recommendations.pdf](http://www.science.org.au/files/userfiles/events/documents/think-tank-risk-recommendations.pdf)

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## THE CONVERSATION

McMahon, R, and Labbate, M (1 February 2017). *When the drugs don't work: how we can turn the tide of antimicrobial resistance*. Retrieved from <https://theconversation.com> on 2 February 2017.



# Vaccine-preventable diseases and immunisation

## IMMUNISATION COVERAGE

### FACT SHEET FROM THE WORLD HEALTH ORGANIZATION

#### KEY FACTS

- Immunisation prevents illness, disability and death from vaccine-preventable diseases including cervical cancer, diphtheria, hepatitis B, measles, mumps, pertussis (whooping cough), pneumonia, polio, rotavirus diarrhoea, rubella and tetanus.
- Global vaccination coverage is generally holding steady.
- Uptake of new and underused vaccines is increasing.
- Immunisation currently averts an estimated 2 to 3 million deaths every year. An additional 1.5 million deaths could be avoided, however, if global vaccination coverage improves.
- An estimated 19.4 million infants worldwide are still missing out on basic vaccines.

#### Overview

Immunisation averts an estimated 2 to 3 million deaths every year from diphtheria, tetanus, pertussis (whooping cough), and measles; however, an additional 1.5 million deaths could be avoided if global vaccination coverage improves. Global vaccination coverage – the proportion of the world's children who receive recommended vaccines – has remained steady for the past few years.

During 2015, about 86% (116 million) of infants worldwide received 3 doses of diphtheria-tetanus-pertussis (DTP3) vaccine, protecting them against infectious diseases that can cause serious illness and disability or be fatal. By 2015, 126 countries had reached at least 90% coverage of DTP3 vaccine.

#### Global immunisation coverage 2015

*Haemophilus influenzae* type b (Hib) causes meningitis and pneumonia. Hib vaccine had been introduced in 191 countries by the end of 2015. Global coverage with 3 doses of Hib vaccine is estimated at 64%. There is

great variation between regions. In the Americas, coverage is estimated at 90%, while it is only 25% and 56% in the Western Pacific and South-East Asia Regions respectively.

*Hepatitis B* is a viral infection that attacks the liver. Hepatitis B vaccine for infants had been introduced nationwide in 185 countries by the end of 2015. Global coverage with 3 doses of hepatitis B vaccine is estimated at 83% and is as high as 90% in the Western Pacific. In addition, 96 countries introduced one dose of hepatitis B vaccine to newborns within the first 24 hours of life, and the global coverage is 39%.

*Human papillomavirus* is the most common viral infection of the reproductive tract, and can cause cervical cancer, other types of cancer, and genital warts in both men and women. Human papillomavirus vaccine was introduced in 66 countries by the end of 2015.

*Measles* is a highly contagious disease caused by a virus, which usually results in a high fever and rash, and

can lead to blindness, encephalitis or death. By the end of 2015, 85% of children had received 1 dose of measles vaccine by their second birthday, and 160 countries had included a second dose as part of routine immunisation and 61% of children received 2 doses of measles vaccine according to national immunisation schedule.

*Meningitis A* is an infection that can cause severe brain damage and is often deadly. By the end of 2015 – 5 years after its introduction – more than 235 million people in African countries affected by the disease had been vaccinated with MenAfriVac, a vaccine developed by WHO and PATH.

*Mumps* is a highly contagious virus that causes painful swelling at the side of the face under the ears (the parotid glands), fever, headache and muscle aches. It can lead to viral meningitis. Mumps vaccine had been introduced nationwide in 121 countries by the end of 2015.

*Pneumococcal diseases* include pneumonia, meningitis and febrile bacteraemia, as well as otitis media, sinusitis and bronchitis. Pneumococcal vaccine had been introduced in 129 countries by the end of 2015, and global coverage was estimated at 37%.

*Polio* is a highly infectious viral disease that can cause irreversible paralysis. In 2015, 86% of infants around the world received 3 doses of polio vaccine. Targeted for global eradication, polio has been

stopped in all countries except for 2: Afghanistan and Pakistan. Polio-free countries have been infected by imported virus, and all countries – especially those experiencing conflict and instability – remain at risk until polio is fully eradicated.

**Rotaviruses** are the most common cause of severe diarrhoeal disease in young children throughout the world. Rotavirus vaccine was introduced in 84 countries by the end of 2015, and global coverage was estimated at 23%.

**Rubella** is a viral disease which is usually mild in children, but infection during early pregnancy may cause foetal death or congenital rubella syndrome, which can lead to defects of the brain, heart, eyes and ears. Rubella vaccine was introduced nationwide in 147 countries by the end of 2015 and global coverage was estimated at 46%.

**Tetanus** is caused by a bacterium which grows in the absence of

oxygen, for example in dirty wounds or in the umbilical cord if it is not kept clean. It produces a toxin which can cause serious complications or death. The vaccine to prevent maternal and neonatal tetanus had been introduced in 106 countries by the end of 2015. An estimated 83% of newborns were protected through immunisation. Maternal and neonatal tetanus persist as public health problems in 19 countries, mainly in Africa and Asia.

**Yellow fever** is an acute viral haemorrhagic disease transmitted by infected mosquitoes. As of 2015, yellow fever vaccine had been introduced in routine infant immunisation programmes in 35 of the 42 countries and territories at risk for yellow fever in Africa and the Americas.

### Key challenges

Last year, the Strategic Advisory Group of Experts on immunisation (SAGE) identified 5 factors to achieving results in immunisation coverage:

- Quality and use of data
- Community involvement
- Better access to immunisation services for marginalised and displaced populations
- Strong health systems
- Access to vaccines in all places at all times.

In 2015, an estimated 19.4 million infants worldwide were not reached with routine immunisation services such as DTP3 vaccine. Around 60% of these children live in 10 countries: Angola, the Democratic Republic of the Congo, Ethiopia, India, Indonesia, Iraq, Nigeria, Pakistan, the Philippines, and Ukraine.

Monitoring data at subnational levels is critical to helping countries prioritise and tailor vaccination strategies and operational plans to address immunisation gaps and reach every person with life-saving vaccines.

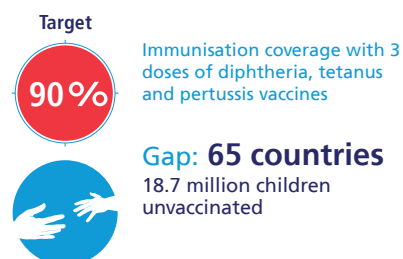
### WHO response

WHO is working with countries and partners to improve global

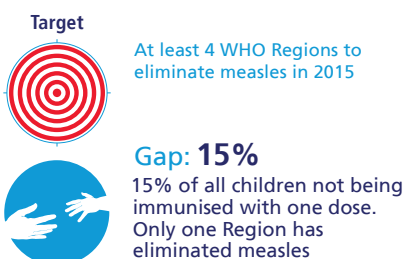
## SIX GOALS OF THE GLOBAL VACCINE ACTION PLAN



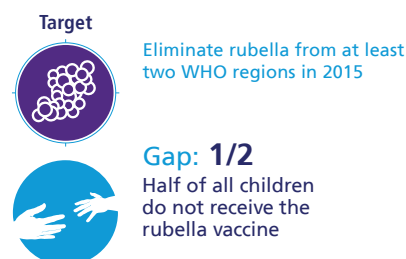
### IMMUNISATION AGAINST DIPHTHERIA, TETANUS AND PERTUSSIS



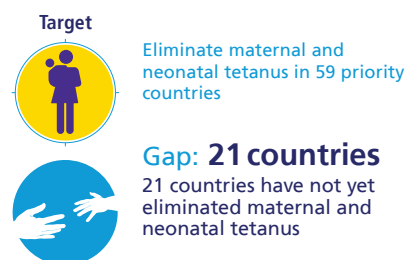
### MEASLES MORTALITY REDUCTION



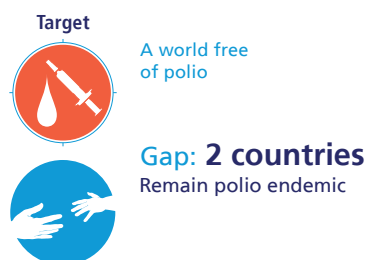
### RUBELLA ELIMINATION



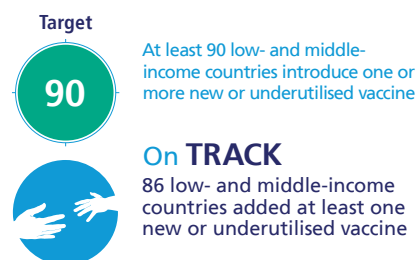
### MATERNAL AND NEONATAL TETANUS ELIMINATION



### POLIO ERADICATION



### USE OF NEW OR UNDERUTILISED VACCINES



vaccination coverage, including through these initiatives adopted by the World Health Assembly in May 2012.

**The Global Vaccine Action Plan**

The Global Vaccine Action Plan (GVAP) is a roadmap to prevent millions of deaths through more equitable access to vaccines.

Countries are aiming to achieve vaccination coverage of at least 90% nationally and at least 80% in every district by 2020. While the GVAP should accelerate control of all vaccine-preventable diseases, polio eradication is set as the first milestone. It also aims to spur research and development for the next generation of vaccines.

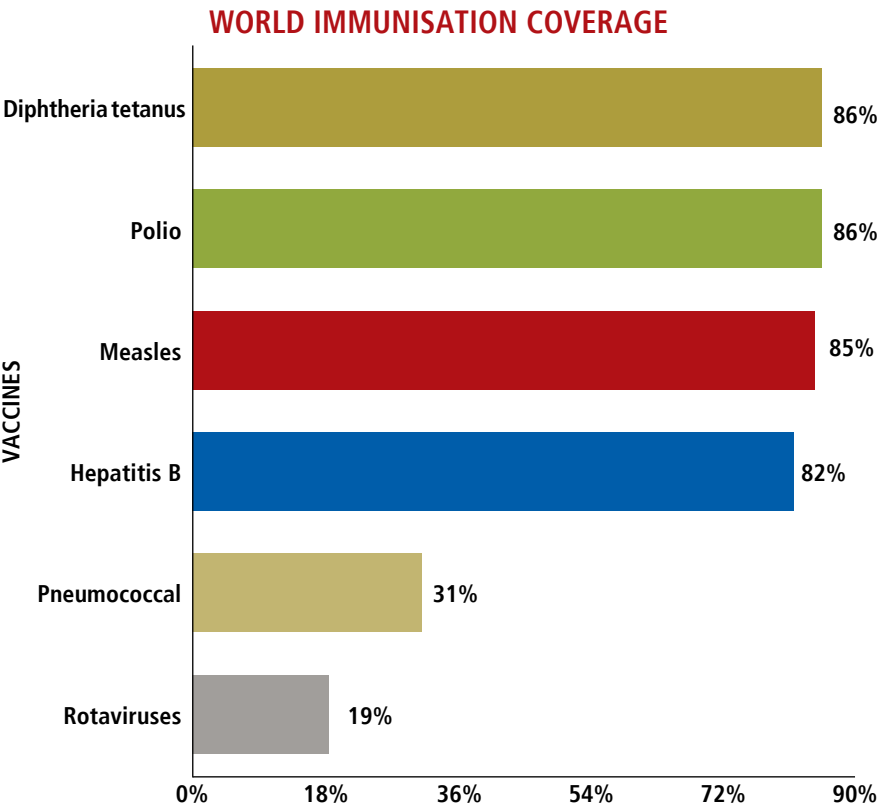
WHO is leading efforts to support regions and countries as they adapt the GVAP for implementation. In April 2016, WHO warned that 5 out of the 6 GVAP targets were off-track, with only 1 target on the introduction of underutilised vaccines showing sufficient progress. This finding was based on the independent assessment report by SAGE.

The GVAP recommends 3 key steps for closing the immunisation gap:



Immunisation averts an estimated 2 to 3 million deaths every year from diphtheria, tetanus, pertussis (whooping cough), and measles; however, an additional 1.5 million deaths could be avoided if global vaccination coverage improves.

- Integrating immunisation with other health services, such as postnatal care for mothers and babies
- Strengthening health systems so that vaccines continue to be given even in times of crisis, and
- Ensuring that everyone can access vaccines and afford to pay for them.



**World Immunisation Week**

The last week of April each year is marked by WHO and partners as World Immunisation Week. It aims to accelerate action to increase awareness and demand for immunisation and improve vaccination delivery services so that people everywhere can be protected against deadly diseases.

In 2016, under the global slogan ‘Close the immunisation gap’, the campaign focused on immunisation for all throughout life. More than 180 countries, territories and areas marked the week with activities including vaccination campaigns, training workshops, roundtable discussions and public information campaigns.

World Health Organization. *Immunization coverage* (Fact sheet). Updated September 2016. Retrieved from <http://www.who.int> on 18 January 2017.

# VACCINES ON THE FRONTLINE AGAINST INFECTIOUS DISEASES

*The World Health Organization estimates that vaccines prevent 2-3 million deaths every year.<sup>1</sup> This paper by **Simon Prasad** at the Office for the Chief Scientist explains what vaccines are, how they work, how they are tested and what they offer for the future*

## BACKGROUND

Vaccines harness the capacity of our immune system to provide protection against diseases caused by pathogens, such as bacteria and viruses, by the process we call ‘immunisation’.

Our awareness of immunisation traces back thousands of years. The ancient Greeks observed that people who recovered from the bubonic plague did not suffer the plague again. It was also common knowledge that survivors of smallpox became resistant to the disease, and survivors were often called on to nurse the sick.<sup>2</sup> In the Middle Ages, people in India and China would expose uninfected people to small amounts of material from the smallpox lesions of sufferers, in the hope that they would be protected.<sup>3</sup>

The modern era of vaccination began in the 18th century through the pioneering work of British doctor Edward Jenner.<sup>2</sup> Jenner observed that milkmaids who suffered mild skin infections from cowpox were resistant to smallpox. He embarked on what we now recognise as the first scientific attempt to control an infectious disease through the deliberate use of vaccination.

In Australia, vaccines have had a profound impact in the decades following their introduction. Deaths from

diphtheria, pertussis (whooping cough), tetanus, polio and measles have either fallen to zero or close to zero.<sup>4</sup>

Following the start of community vaccination against measles in 1970, for example, the number of measles-related deaths fell from 146 in the decade 1966-1975 to zero in 1996-2005.

Routine vaccination (Box 1)<sup>5</sup> has also led to a decline in the number of infections.

*“It was a terrific thrill to be involved in a program which in 10 years removed from the Earth a disease which, at the time we started, was credited with 20 million cases and two million deaths every year.”*

– Professor Frank Fenner in 2002, on accepting the Prime Minister’s Prize for Science in Australia for his role in eradicating smallpox.

## HUMANITY’S SHIELD

Across the globe, vaccination is recognised as a critical tool in the fight against disease.

Several highly infectious and debilitating diseases are now rare because they are prevented by vaccines. Smallpox has been eradicated throughout the world, a triumph in which Australian immunologist Professor Frank Fenner played a central role.



## BOX 1: CHILDHOOD VACCINATION IN AUSTRALIA

Routine childhood immunisations given through the Immunise Australia Program currently provide protection against 13 diseases (below), most of which can cause serious illness and sometimes death.

- Diphtheria
- Haemophilus influenzae type b (Hib)
- Hepatitis B
- Measles
- Meningococcal C
- Mumps
- Whooping cough (pertussis)
- Pneumococcal disease
- Polio (poliomyelitis)
- Rotaviral gastroenteritis
- Rubella (German measles)
- Tetanus
- Chickenpox (varicella)

Adapted from *The Australian Immunisation Handbook 2013* (10th ed), [www.health.gov.au/internet/immunise/publishing.nsf/Content/Handbook10-home](http://www.health.gov.au/internet/immunise/publishing.nsf/Content/Handbook10-home)

Global deaths caused by measles fell from 535,300 in 2000 to 139,300 in 2010.<sup>6</sup>

Polio is on the brink of being eradicated, with the number of cases worldwide falling by more than 99 per cent since 1988.<sup>7</sup> In 1988, more than 125 countries recorded polio cases. Today only three – Afghanistan, Pakistan and Nigeria – have yet to eradicate the disease.

### Constant vigilance

While governments and health professionals have worked hard to spread the benefits of vaccination, the re-emergence of vaccine-preventable diseases in the United States, the United Kingdom, France and Japan demonstrates the need for constant vigilance.<sup>8</sup>

In 2013, a measles outbreak in the United Kingdom mainly affected children whose parents had opted against the measles-mumps-rubella (MMR) vaccine.<sup>8</sup> A claimed but now discredited ‘link’ between the MMR vaccine and autism played a significant role in spreading fear.<sup>9</sup> Such fears can be amplified in communities which have not seen or experienced the diseases that vaccinations prevent.

### HOW DO VACCINES WORK?

Our immune system is a complex network of cells and organs that have evolved to defend the body against ‘foreign invaders’.<sup>10</sup> Much of the defence is mounted by specialist cells that are mobilised following an infection.

Chief among these are the B cells and T cells.

**TABLE 1: HERD IMMUNITY THRESHOLDS FOR VACCINE PREVENTABLE DISEASES**

| Disease    | Herd immunity |
|------------|---------------|
| Diphtheria | 85%           |
| Measles    | 83-94%        |
| Mumps      | 75-86%        |
| Pertussis  | 92-94%        |
| Polio      | 80-86%        |
| Rubella    | 83-85%        |
| Smallpox   | 80-85%        |

Adapted from The Centers for Disease Control and Prevention, *History and epidemiology of global smallpox eradication*, [www.bt.cdc.gov/agent/smallpox/training/overview/pdf/eradicationhistory.pdf](http://www.bt.cdc.gov/agent/smallpox/training/overview/pdf/eradicationhistory.pdf)

B cells are like factories that make precision weapons. The weapons are proteins called antibodies. Antibodies attached to an invader make it useless, or flag it for elimination by other cells of the immune system.

T cells join the offence against infection. Killer T cells directly destroy invaders; whilst helper T cells assist the B cells to do their job.

When the immune system first encounters a pathogen it ‘remembers’ it by keeping a small pool of long-lasting ‘memory’ B cells against that pathogen.<sup>10</sup> These cells reside mainly in the spleen and circulate in small numbers in blood.<sup>11</sup>

They represent a rapid response force that deal with subsequent infections. It is this memory that is the foundation of our resistance to future infections with the same pathogen.

### Building the body’s defences

Vaccinations are designed to trigger a protective immune response against a specific pathogen, without causing illness. Some vaccines can also protect against the longer-term complications of infections, which include liver cancer and cervical cancer.

Modern vaccines usually have two main ingredients: **antigens**, and **adjuvants**.<sup>10</sup>

**Antigens** are killed or weakened pathogens or pathogen components. Some vaccines contain virus or bacteria killed by heat or chemical treatment. Others contain live virus or bacteria that have been weakened by growing them under particular conditions in the laboratory. For example, the measles vaccine contains weakened forms of the virus that do not cause disease.

An **adjuvant** amplifies an immune response above what is caused by the antigen alone. The aluminium salt alum, for example, creates a depot of antigens at the site of injection, boosting the recruitment of immune cells to the site. Alum also helps deliver antigens to the draining lymph nodes where an immune response to the antigen begins. The safety record of aluminium adjuvants is reflected in the fact that they have now been in use for 70 years.<sup>12</sup>

### Herd immunity

In countries with high vaccination rates, such as Australia<sup>13</sup>, the spread of disease is limited.

This indirectly protects unvaccinated or vulnerable individuals (such as newborn babies and cancer patients

**FIGURE 1: CALCULATING VACCINE RISKS**

|                                                                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>COMMON: MORE THAN 1 IN 100 DOSES</b><br>Redness, swelling or soreness at the site of an injection are common for many vaccines, as are mild fevers. Nausea, vomiting and diarrhoea have been reported for a few. |
| <b>LESS COMMON: 1 IN 100 TO 1 IN 100,000</b><br>High fevers can occur in this range, as can fever-induced convulsions from vaccines such as that for measles, mumps and rubella (1 in 3,000 doses).                 |
| <b>RARE: 1 IN 100,000 TO 1 IN 1 MILLION</b><br>Severe allergic reactions to vaccines are generally uncommon, in the order of 1 in 1 million.                                                                        |
| <b>INCONCLUSIVE: NOT ENOUGH DATA</b><br>Guillain-Barré syndrome, a paralytic disorder, has been associated with some seasonal influenza vaccines, but a causal link has not been established.                       |

Adapted from *Calculating risks*, US Centers for Disease Control and Prevention, [www.nature.com/news/2011/110525/full/473436a/box/1.html](http://www.nature.com/news/2011/110525/full/473436a/box/1.html)

undergoing chemotherapy) through what is known as ‘herd immunity’.

The threshold required to secure this benefit depends on both the disease and the vaccine.

For example, herd immunity for measles requires 83-94 per cent vaccine coverage in the community (Table 1).<sup>14</sup>

## VACCINE PRODUCTION

The process of making vaccines is complex and depends on the type of vaccine. As an overview of the steps involved, consider vaccines for influenza. The process involves three key steps: growing the weakened forms of the virus; isolating and purifying the virus or its components; and making them into vaccines.<sup>14</sup>

The first step is to grow the virus. Chicken eggs are commonly used to grow the influenza virus.

The next step is to isolate and purify the weakened virus (for the nasal spray vaccine) or antigens derived from it (for the injected vaccine).

If required, the final formulation step includes the

**TABLE 2: THE WORLD’S MOST INFECTIOUS DISEASES**

| Disease             | Number of carriers | Deaths      |
|---------------------|--------------------|-------------|
| <b>Tuberculosis</b> | 2 billion          | 1.3 million |
| <b>Malaria</b>      | 207 million        | 627,000     |
| <b>HIV</b>          | 35.3 million       | 1.6 million |

Data reported in 2011 (Tuberculosis) and 2012 (Malaria and HIV) Source: (Bourzac K, *Nature* vol 507, 2014, s4-7).

addition of adjuvants.

Vaccines can contain trace quantities of material used during the production process. These can include nutrients (for example, egg proteins) and chemicals used to kill the virus.

Regulatory authorities require vaccine makers to test for such material and ensure that they do not exceed safety limits.<sup>15</sup>

## VACCINES ARE SAFE AND EFFECTIVE

The risks of severe effects from diseases are far greater than the risks of side effects from vaccinations in use in Australia.<sup>3,15</sup>

Serious complications, such as severe allergic reactions, are extremely rare. The vast majority of side effects which are observed are mild and short-lived, such as swelling and redness at the site of injection (Figure 1).<sup>16</sup> Fevers following vaccination are much less common.

The safety and effectiveness of any vaccine used in Australia is established with a series of rigorous testing processes (Figure 2)<sup>3</sup>, with the bar set very high.

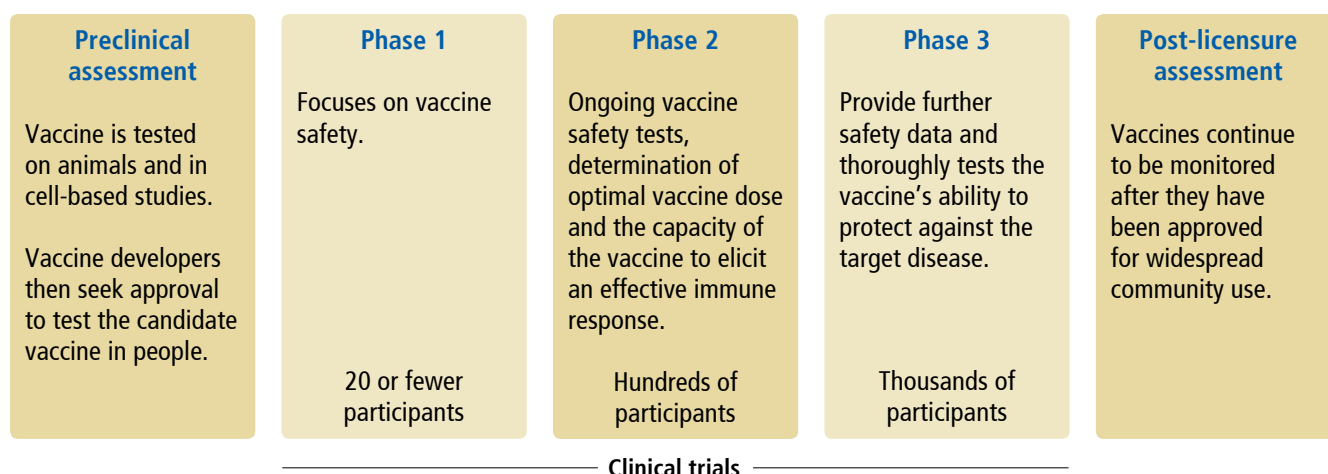
## THE NEW FRONTIER

There are no effective vaccines against tuberculosis (TB), malaria and human immunodeficiency virus (HIV), currently the world’s three deadliest infectious diseases (Table 2).<sup>17</sup>

These three diseases ‘hide’ within affected individuals and do not elicit natural immunity, so vaccine developers need to use innovative strategies and technologies.<sup>18</sup>

**FIGURE 2: STAGES OF VACCINE TESTING**

Following regulatory approval, a candidate vaccine enters three phases of clinical trials, each involving an increasing number of human volunteers.



Source: *The Science of Immunisation*, The Australian Academy of Science, 2012.



These include targeting every stage of the complex life cycle of the malaria parasite, using novel genetic analysis to reveal the different immune responses elicited by TB, and gaining further insights into the weaknesses of HIV through basic science.

While the Ebola virus and its horrific symptoms have been known since the 1970s, efforts to develop an Ebola vaccine have been accelerated by the scale of the current epidemic in West Africa. An Ebola vaccine, developed through a public-private partnership, is showing positive preliminary results in early clinical trials.<sup>18</sup>

New strains of the influenza virus are expected to cause three severe influenza pandemics every century.<sup>19</sup> The last pandemic in 2009 turned out to be mild, but exposed our limited capacity to produce influenza vaccines, with a global production capacity of 850 million doses.<sup>19</sup>

Major changes are required in both influenza vaccine production and pandemic preparedness to produce and quickly supply the billions of doses that could be required during a severe influenza pandemic.

New technologies are also under development to improve vaccine delivery.<sup>3</sup> Priorities include vaccines that need to be given only once, needle-free vaccination and plant-based edible vaccines.

*“New vaccines nearly always give public health its biggest leap forward. Of course, everyone would love to see a vaccine developed for the high-mortality killers, like HIV and malaria, and a better vaccine for tuberculosis.”*

– Dr Margaret Chan, Director-General of the World Health Organization, 2011.

## CONCLUSION

Scientific and technological advances in vaccine development hold the promise of a future free from most infectious diseases. Recent disease epidemics in

developed nations demonstrate that a fall in vaccine coverage in the community will inevitably lead to the reemergence of diseases of the past. The challenge for all nations is to foster both the science and the scientific awareness of vaccination to keep our communities safe.

## REFERENCES

1. World Health Organization, *Immunisation Coverage* WHO fact sheet No. 378, 2015.
2. S. Riedel, 'Edward Jenner and the history of smallpox and vaccination', *Proc Bayl Univ Med Cent* 18, 21-25 (2005).
3. *The science of immunisation*, The Australian Academy of Science (2012).
4. C. Chiu, A. Dey, H. Wang, R. Menzies, S. Deeks et al., *Vaccine preventable diseases in Australia, 2005 to 2007* (Department of Health and Ageing, 2010).
5. Australian Government Department of Health, *The Australian Immunisation Handbook* (Ed. 10, Canberra, 2013).
6. E. Simons, M. Ferrari, J. Fricks, K. Wannemuehler, A. Anand et al., 'Assessment of the 2010 global measles mortality reduction goal: results from a model of surveillance data', *Lancet* 379: 2173-78 (2012).
7. World Health Organization, *Poliomyelitis* WHO Fact Sheet No. 114, 2014; [www.who.int/mediacentre/factsheets/fs114/en/](http://www.who.int/mediacentre/factsheets/fs114/en/).
8. M. Eisenstein, 'Public health: an injection of trust', *Nature* 507: s17-19 (2014).
9. F. DeStefano, C.S. Price, E.S. Weintraub, 'Increasing exposure to antibody-stimulating proteins and polysaccharides in vaccines is not associated with risk of autism', *J Pediatr* 163, 561-567 (2013).
10. *Understanding Vaccines – What they are, how they work*, US Department of Health and Human Services (2008).
11. M. Mamani-Matsuda, A. Cosma, S. Weller, A. Faili, C. Staib, et al., 'The human spleen is a major reservoir for long-lived vaccinia virus-specific memory B cells', *Blood* 111, 4653-4659 (2008).
12. H. Hogenesch, 'Mechanism of immunopotentiality and safety of aluminum adjuvants', *Front Immunol* 3:406 (2012).
13. Department of Health, Immunise Australia Program (retrieved: May 2015), [www.immunise.health.gov.au/internet/immunise/publishing.nsf/Content/acir-curr-data.htm](http://www.immunise.health.gov.au/internet/immunise/publishing.nsf/Content/acir-curr-data.htm)
14. Centers for Disease Control and Prevention, *History and epidemiology of global smallpox eradication* (2014), [www.bt.cdc.gov/agent/smallpox/training/overview/pdf/eradicationhistory.pdf](http://www.bt.cdc.gov/agent/smallpox/training/overview/pdf/eradicationhistory.pdf)
15. S.A. Plotkin, W.A. Orenstein, P.A. Offit, *Vaccines* (Elsevier, ed. 6, 2013).
16. R. Kwok, 'Cell biology: The new cell anatomy', *Nature* 473:436-438 (2011).
17. K. Bourzac, 'Infectious disease: the big three', *Nature* 507: s4-7 (2014).
18. T. Rampling, K. Ewer, G. Bowyer, D. Wright, E.B. Imoukhuede et al., 'A Monovalent Chimpanzee Adenovirus Ebola Vaccine – Preliminary Report', *New Eng J Med* Jan pp.1-10 (2015).
19. K. Stohr, 'Perspective: Ill prepared for a pandemic', *Nature*, 507: s20-21 (2014).

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Prasad, S (June 2015). 'Vaccines on the frontline against infectious diseases', *Occasional Paper Series*, Issue 10. Retrieved from [www.chiefscientist.gov.au](http://www.chiefscientist.gov.au) on 15 September 2016.

# VACCINE-PREVENTABLE DISEASE

## STATISTICS FROM THE AUSTRALIAN INSTITUTE OF HEALTH AND WELFARE

Vaccination is one of the most successful and cost-effective population health interventions. It can protect individuals from life-threatening diseases, and also reduces transmission in the community.

**V**accination is one of the most successful and cost-effective population health interventions. It can protect individuals from life-threatening diseases, and also reduces transmission in the community.

This snapshot looks at the most common notifiable vaccine-preventable diseases (VPDs) in Australia. Notifiable diseases are medical conditions that are required to be reported by health practitioners or pathology laboratories to state or territory health authorities. Notifications data are presented for 2013 and 2014, and underlying causes of death data for 2013. Information on childhood vaccination is in 'Chapter 6.1 Prevention and health promotion'.

In 2014, about 275,600 notifications of more than 60 communicable conditions and diseases were made to the National Notifiable Diseases Surveillance System (NNDSS) – 23% more than in 2013 (about 224,400) (NNDSS Annual Report Writing Group 2015b, forthcoming 2016) (Table 3.17.1).

More than one-third (about 101,400, or 37%) of the notifications in 2014 were for VPDs – a 70% increase

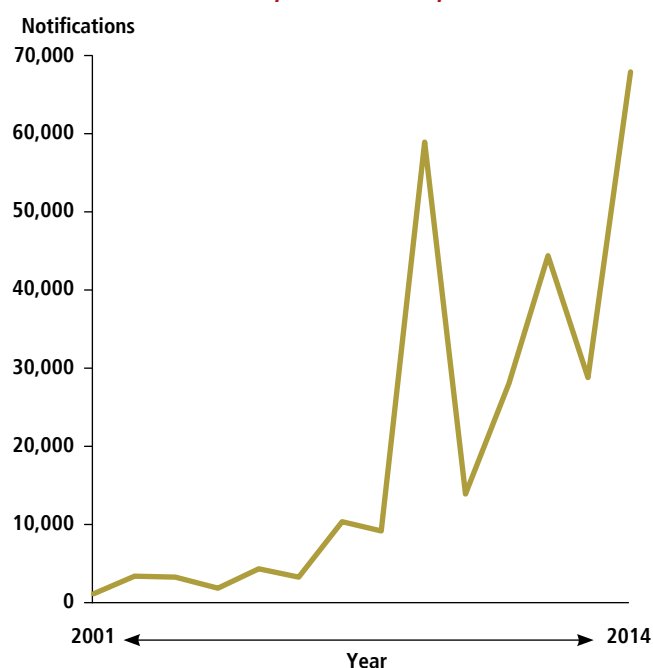
on the 59,600 VPD cases notified in 2013 (27% of total notifications) (NNDSS Annual Report Writing Group 2015b, forthcoming 2016). Much of this was due to a rise in influenza notifications (see Figure 3.17.1).

It should be noted that influenza notifications can vary substantially from year to year due to the variation in true disease incidence as well as the propensity to notify. Factors that influence variation in true disease incidence include the similarity of circulating strains to vaccine strains, and a person's age, level of immunity and any other chronic medical conditions they may have.

Notifications represent cases where a person has sought medical care, had a test performed, been given a diagnosis, and a notification has been made to health authorities. For all notifiable diseases, the number of notifications is influenced by a range of factors, including public awareness, individual behaviours of patients, and the testing and notification practices of medical practitioners. Changes to testing policies; preferential testing of high-risk populations; the use of less invasive and more sensitive diagnostic tests; periodic awareness campaigns and media coverage may all influence the number of notifications received. These factors are likely to vary by region and over time, and are difficult to quantify.

For most diseases, the cases notified to the NNDSS represent only a proportion of total cases that occur in the community.

**FIGURE 3.17.1: INFLUENZA NOTIFICATIONS, AUSTRALIA, 2001-2014**



Source: National Notifiable Diseases Surveillance System.

Note: Influenza was first added to the list of notifiable diseases in 2001 and data for that year is incomplete.

### Impact of vaccine-preventable diseases

- Several previously common VPDs have been eliminated or are now rare, including diphtheria (2 cases in 2014) and poliomyelitis (0 cases) (Table 3.17.1)
- Influenza was the most commonly notified VPD in 2014 (about 67,700 cases)
- In 2014, the varicella zoster virus, which causes chickenpox and shingles, was the next most commonly notified VPD (about 19,600 cases) after influenza
- In 2013, there were 80 deaths recorded due to influenza, 32 due to the varicella zoster virus (29 of which were associated with cases of shingles), and 12 due to pneumococcal disease. This compares with 152 influenza deaths in 2012 (about 44,600 notifications), 26 shingles deaths (about 4,500 notifications) and 24 pneumococcal deaths (about 1,800 notifications) (ABS 2015; NNDSS Annual Report Writing Group 2015a). However, deaths and hospitalisations recorded as due to influenza are widely acknowledged to substantially underestimate the true number attributable to influenza, because the illness can exacerbate a range of other medical conditions, leading to hospitalisation or death (NCIRS 2010).

**TABLE 3.17.1: MOST COMMONLY NOTIFIED VACCINE-PREVENTABLE DISEASES, NOTIFICATIONS 2013 AND 2014, DEATHS 2013**

| DISEASE                                  | Notifications 2014 | Notifications 2013 | Deaths 2013       |
|------------------------------------------|--------------------|--------------------|-------------------|
| Influenza                                | 67,742             | 28,329             | 80                |
| Varicella zoster (total)                 | 19,658             | 16,986             | 32                |
| Pertussis                                | 11,863             | 12,341             | 2                 |
| Pneumococcal (invasive)                  | 1,564              | 1,546              | 12 <sup>(a)</sup> |
| Measles                                  | 340                | 158                | 1                 |
| Mumps                                    | 190                | 217                | 0                 |
| Haemophilus influenzae type b (invasive) | 21                 | 20                 | n.p.              |
| Rubella                                  | 17                 | 25                 | 0                 |
| Tetanus                                  | 3                  | 4                  | 1                 |
| Diphtheria                               | 2                  | 2                  | 0                 |
| Congenital rubella                       | 0                  | 2                  | 0                 |
| Poliomyelitis infection                  | 0                  | 0                  | 0                 |
| <b>Total</b>                             | <b>101,400</b>     | <b>59,630</b>      | <b>128</b>        |

n.p. not published.

(a) Deaths data is only for pneumonia due to *Streptococcus pneumoniae*.

Sources: ABS 2015; NNDSS Annual Report Writing Group 2015b, forthcoming 2016.

### Hospitalisations for vaccine-preventable diseases

In 2013-14, there were nearly 12,000 hospitalisations due to vaccine-preventable pneumonia (pneumonia due to *Streptococcus pneumoniae* and *Haemophilus influenzae*) and to influenza, and another 19,400 due to other VPDs. Hospitalisations are included in this analysis regardless of whether these diseases are the principal diagnosis or an additional diagnosis.

Some population groups had higher rates of hospitalisation per 1,000 population for vaccine-preventable diseases than other Australians (AIHW 2015).

For example rates were:

|                                                                                                             |                                                                                        |                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| <b>6.3 per 1,000</b> for Indigenous Australians compared with 0.9 per 1,000 for non-Indigenous Australians. | <b>7.2 per 1,000</b> in Very remote areas compared with 1.3 per 1,000 in Major cities. | <b>2.0 per 1,000</b> in lowest socio-economic areas compared with 0.8 per 1,000 in highest socioeconomic areas. |
|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|

### What is missing from the picture?

Notifications of VPDs to the NNDSS represent only a portion of all the cases occurring in the community, as not all individuals with VPDs present for medical care, and of those who do, not all are tested and/or notified. The proportion of under-reporting may vary between diseases, over time, and across jurisdictions.

The number of notifications may be influenced over time by changes in testing practices, for example, by an increased propensity to test and/or to use more sensitive diagnostic tests, and these changes may be influenced by both clinician practice and patient expectations.

### Where do I go for more information?

More information on VPDs is available at the Department of Health website. Information on immunisation

is available from the National Centre for Immunisation Research and Surveillance website and the Immunise Australia Program. Information on national notification data is available from the NNDSS pages of the Department of Health website. Information on deaths in Australia is available at the AIHW and Australian Bureau of Statistics websites.

To overcome the limitations of the notification data in describing the epidemiology of influenza, notification data are complemented by a number of systems within the National Influenza Surveillance Scheme.

More information is available at: [www.health.gov.au/flureport](http://www.health.gov.au/flureport)

### REFERENCES

- ABS (Australian Bureau of Statistics) 2015. *Causes of death, Australia, 2013* (Table 1.1). ABS cat. no. 3303.0. Canberra: ABS.
- AIHW (Australian Institute of Health and Welfare) 2015. Admitted patient care 2013-14: Australian hospital statistics. *Health services series* no. 60. Cat. no. HSE 156. Canberra: AIHW.
- NCIRS (National Centre for Immunisation Research & Surveillance) 2010. Vaccine preventable diseases in Australia, 2005 to 2007. *Communicable Diseases Intelligence* 34 (Supplement 37).
- NNDSS (National Notifiable Diseases Surveillance System) Annual Report Writing Group 2015a. Australia's notifiable disease status, 2012: annual report of the National Notifiable Disease Surveillance System. *Communicable Diseases Intelligence* 39(1):E46-136.
- NNDSS Annual Report Writing Group 2015b. Australia's notifiable disease status, 2013: annual report of the National Notifiable Disease Surveillance System. *Communicable Diseases Intelligence* 39(3):387-477.
- NNDSS Annual Report Writing Group, forthcoming 2016. *Australia's notifiable disease status, 2014*. Annual report of the National Notifiable Disease Surveillance System.

Australian Institute of Health and Welfare (June 2016). *Australia's health 2016*, 3.17 Vaccine preventable disease, pp. 123-126. Retrieved from [www.aihw.gov.au](http://www.aihw.gov.au) on 13 September 2016.

# FACT FILE: IMMUNISATION

**Dr Jocelyn Lowinger** explains immunisation in this ABC Health & Wellbeing fact file

**I**mmunisation involves introducing a dead or weakened version of a bacteria or virus into the body with a vaccine. This allows our immune system to respond more quickly to fight an infection when it encounters the 'real' bacteria or virus.

Immunisation saves about three million lives a year worldwide and is one of the top four medical advances in past 150 years along with sanitation, antibiotics and anaesthesia. It is a safe and effective way to prevent the spread of many infectious diseases.

## What is a vaccine?

Vaccines are available for a range of viruses and bacteria that can cause illness. All vaccines work in the same way, they contain a part of the microbe (known as an antigen) that causes the disease.

When you are vaccinated your body produces antibodies against the antigen in the vaccine. If you are later exposed to the virus or bacteria, your body can respond to the infection quickly, which means you may not get the illness at all or if you do you'll likely get it in a milder form and be less likely to get serious complications.

There are three main types of vaccines and in all cases, the microbes have been changed so they can trigger your immune response without causing the actual disease.

- **Live attenuated virus.** This is a virus that has been weakened so they are less virulent, without reducing their ability to induce a strong immune response. In very rare cases these can cause disease. (In Australia these may include vaccines for measles, mumps, rubella (MMR); chicken pox and tuberculosis. These are not recommended for pregnant women and talk to your doctor if you have a problem in your immune system to see if these vaccines are suitable for you.)
- **Inactivated whole agents.** These are complete viruses or bacteria that have been killed so they cannot cause disease.
- **Modified toxin produced by bacteria.** These types of vaccines cannot cause the disease.

## What vaccines when?

The National Immunisation Program Schedule contains the most up-to-date immunisation recommendations for Australia. The schedule outlines the recommended and fully funded vaccine plan by age group for the Immunise Australia Program.

## Children to age 5

The immunisation schedule for children until age 4 currently includes vaccination against the following diseases (in alphabetical order):

- Chickenpox (*varicella*)
- Diphtheria
- Haemophilus influenzae type b (Hib)
- Hepatitis B
- Polio
- Measles
- Meningococcal C
- Mumps
- Pneumococcal
- Rotavirus
- Rubella
- Tetanus
- Whooping cough (*acellular pertussis*).

Immunisations are recommended at birth, 2, 4, 6, 12 and 18 months then at 4 years. Vaccines need to be given several times to ensure long-lasting protection.

Up to eight vaccines may be given at a time. To reduce the number of injections – and the risk of missing a dose – some vaccines are combined, like diphtheria, tetanus, pertussis (DTPa) and measles, mumps, rubella (MMR).

*Immunisation saves about three million lives a year worldwide and is one of the top four medical advances in past 150 years along with sanitation, antibiotics and anaesthesia. It is a safe and effective way to prevent the spread of many infectious diseases.*

## School-aged children

School-aged children between 10 and 15 are recommended to be vaccinated against:

- Chickenpox (*varicella*)
- Diphtheria
- Hepatitis B (hepB)
- Human papillomavirus (HPV)
- Tetanus
- Whooping cough (*acellular pertussis*).

These can be given through school-based programs, run by each state and territory, or by GPs. Catch up immunisations children may have missed when they were smaller can also be provided.

## Adults and people at higher risk

Adults age 65 and over are recommended to be vaccinated with annual influenza (flu) shots and a pneumococcal shot at age 65 (or two doses five years apart from age 50 in Indigenous Australians).

As well, certain groups of people who are considered at higher risk of certain diseases may require additional vaccinations to protect them and the people they come into contact with.

If you have some of the following medical conditions you may require additional vaccinations:

- A chronic illness e.g. heart, lung or kidney disease,

- Diabetes
- HIV or another condition causing impaired immunity
- Pregnancy.

Aboriginal and Torres Strait Islanders require additional vaccinations as their risk of certain diseases is slightly different:

- An additional booster dose of pneumococcal vaccine between 12-18 months
- Hepatitis A vaccination at 6 and 12 months
- Annual influenza vaccination from six months to five years and from age 50
- Two doses five years apart of pneumococcal vaccination from age 50.

Pregnant women are recommended to have annual flu shots. Vaccination against whooping cough may be required if you have not been vaccinated in the past five years. This will provide antibodies for your baby to protect them in their first few months of life.

If you are travelling overseas get in touch with your GP or travellers' health clinic to discuss which vaccinations you might need, make sure you do this well before your departure. Don't forget to make sure that all your standard immunisations like measles, chicken pox and hepatitis B are up to date.

## Getting vaccinated

**How are vaccines given?** Most vaccines are given by injection. Some are given by mouth.

If you are taking your child for a vaccination, you can help reduce the discomfort of injections by:

- Wrapping, cuddling or holding your child firmly
- Distracting them by shaking a toy or playing music
- Breastfeeding (while the injection is being given)
- Giving a few drops of a sweet tasting liquid before the injection is given (e.g. sucrose drops).

A local anaesthetic patch is only recommended for children with an intense fear of needles or injections.

**Where to get vaccinated?** There are a number of ways to get your child (or yourself) immunised including:

- In hospital – appointments may be made at birth
- Maternity/child health services in your area
- School or childcare based immunisation programs
- Your GP.

**What vaccinations are needed?** To find out what vaccinations you (or your child) have already had and/or need ask your GP, who will have a record. For children under 7 you can check the Australian Childhood Immunisation Register.

## Has the immunisation program been successful?

Vaccination saves about three million lives a year worldwide and is one of the top four medical advances in past 150 years along with sanitation, antibiotics and anaesthesia.

The majority of Australian children have been fully vaccinated. In 2012 around 92 per cent of 12, 24 and 60 month-old children had been fully immunised. These rates have been slowly increasing since 2000.

Coverage rates have also been growing for indigenous children. In 2012 the percentage of fully vaccinated indigenous children at 12, 24 and 60 months was 86 per cent, 92 per cent and 91 per cent respectively.

Such high coverage rates are reflected in much lower rates of several previously widespread childhood diseases. Some key achievements of the Australian vaccination program include:

- Virtual disappearance of diphtheria and polio.
- No cases of congenital rubella due to infection acquired in Australia since 1998, although there have been five cases from infections caught outside Australia.
- A sustained decline in meningococcal C disease in 1-19 year olds.
- A 95 per cent reduction in *Haemophilus influenza* type b (Hib) infections.
- A 69 per cent reduction in hospitalisations due to chicken pox (*varicella*) in children aged 1.5 to 4 years.
- A >70 per cent reduction in people hospitalised with gastroenteritis due to the rotavirus vaccination.
- A 48 per cent reduction in the number of high-grade cervical abnormalities in girls <18 years.
- Marked reduction in invasive pneumococcal disease (pneumonia, blood poisoning or meningitis) in children and adults ≥65 years.

### What about measles and whooping cough?

- Measles no longer circulates in the Australian community and it is thought to have been eradicated from Australia. However outbreaks of measles overseas due to lower vaccination coverage means travellers are at risk of catching measles overseas and bringing it back into the country. Measles is often severe and it can be fatal. Australians at most risk of catching measles are infants under 12 months old, children between 1 and 2 year olds who haven't yet been vaccinated, and people born in the late 1960s to mid-1980s.
- Whooping cough (*pertussis*) continues to circulate in the community and there are epidemics every three to four years in Australia. Epidemics are less severe and occur further apart in communities with high vaccination rates. Full vaccination provides up to 80 per cent protection until age six. However immunity to *pertussis* reduces with age, which makes boosters necessary. Most hospitalisations and deaths occur in infants younger than two months, who have not been able to have their first dose yet. Strategies to protect newborns include indirectly protecting them by immunising household contacts and carers (known as cocooning) and immunising pregnant women during the last trimester of pregnancy. Recent research suggests the newer acellular vaccine that has fewer side effects is not as good at preventing pertussis than the older whole cell vaccine.

## WHAT ABOUT OTHER SAFETY CONCERNS

There are many mixed and confusing claims about the safety of vaccination. Most of these claims have no scientific basis.

While no vaccine or medication can be considered 100 per cent safe, all are extensively tested for safety before they can be sold in Australia. They are also reviewed on an ongoing basis through the reporting to the Therapeutic Goods Administration.

There is no evidence that vaccines can cause problems such as asthma, diabetes, cancer, mad cow disease or sudden infant death syndrome (SIDS).

There is no evidence that the measles-mumps-rubella (MMR) vaccination causes inflammatory bowel disease or autism. This theory arose from a paper that was published in 1998 by researchers in the UK. Since then the research paper has been retracted and found to be fraudulent. Many studies done since then including large number of children have not shown any link between MMR vaccine and autism or inflammatory bowel disease.

What if my child has an illness? Children with minor illnesses can still be vaccinated as planned. If they have an illness with fever  $\geq 38.5^{\circ}\text{C}$  they may need to wait until they are well.

For most other conditions, children can safely be vaccinated including if they are on antibiotics, have asthma, are being treated with steroids or their mother is pregnant. Talk to your GP if you are unsure.

## How well do vaccines work?

Since childhood vaccinations were introduced into Australia, the death rate from infectious diseases has fallen by 99 per cent, even though the population has tripled in size. When immunisation levels drop against certain diseases, e.g. measles and whooping cough, then we can get outbreaks and epidemics. That's why it's important that we keep vaccinating people, even if it appears there is no longer a problem from vaccine preventable diseases.

Vaccines are very effective, but not everybody who receives a full course is fully protected against the disease.

So how well does vaccination protect against certain diseases? Here are some percentages of those protected against certain conditions after vaccination:

- More than 95 per cent of children who receive a full course of vaccination against measles, mumps, rubella, tetanus, polio and *Haemophilus influenzae* type B
- More than 90 per cent of children who have one dose of meningococcal C vaccine
- About 85 per cent of children who have received three doses of whooping cough vaccine and reduces the severity of the illness in the vaccinated children who do get the illness.

The immunity you get from a vaccine may be quite long-lasting, but it's rarely life-long. That's why booster

doses are usually needed. In contrast, 'natural immunity' acquired by catching most diseases usually lasts a lifetime. The downside is, you have to catch the disease first – risking a serious illness, and in some cases death.

## How safe are vaccines?

Before a vaccine is approved in Australia, the manufacturer must demonstrate the quality, efficacy and safety of the product to the satisfaction of the Therapeutic Goods Administration. The manufacturer must also extensively test each batch for quality, potency and safety prior to distribution.

## Side effects

Vaccines, like any medicine, can cause side effects. Most of these are mild and there are no longlasting problems. Serious reactions to immunisation are very rare – but if they occur see your doctor immediately.

- **Local reactions** – These reactions are common and include reports of pain at the injection site, redness or swelling.
- **Fever** – Fever is common and can cause irritability in young children. Give your child extra fluids, don't overdress them, and consider using paracetamol if they are distressed. Febrile convulsions (convulsions caused by high fever) are very rare and if they occur see your doctor.
- **Fainting** – fainting can occur in adults and older children immediately or soon after vaccination. People who feel giddy or light-headed should lie down until the feeling passes. Most fainting occurs within five minutes, but may also occur up to 30 minutes.
- **Anaphylaxis** – immediate collapse due to an allergic reaction to a component in the vaccine. Although it's potentially life-threatening, it occurs in only one to three cases per million vaccinations, and is treatable.

Other serious side effects are extremely rare. Most are the same side effects the disease can cause, but they usually happen hundreds to thousands of times less frequently.

## Reporting adverse events

Any unintended medical reaction following an immunisation (or after taking any medicine) is called an adverse event. If you or your child has an adverse event following immunisation and you are concerned seek medical advice from your GP or go to the Accident and Emergency department of your local hospital.

You can report an adverse event after a vaccination directly to the Therapeutic Goods Administration. Surveillance for both common and rare side effects is important to identify new or rare problems with vaccines.

Lowinger, J. 'Fact File: Immunisation', *ABC Health & Wellbeing*. Updated 23 April 2015. Retrieved from [www.abc.net.au/health](http://www.abc.net.au/health) on 13 September 2016.

# National Immunisation Program Schedule

The latest schedule from the **Department of Health** (from November 2016)

| CHILD PROGRAMS                                                                                                       |                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AGE                                                                                                                  | VACCINE                                                                                                                                                                                                                                                                                       |
| <b>Birth</b>                                                                                                         | <ul style="list-style-type: none"> <li>Hepatitis B (hepB)<sup>a</sup></li> </ul>                                                                                                                                                                                                              |
| <b>2 months</b>                                                                                                      | <ul style="list-style-type: none"> <li>Hepatitis B, diphtheria, tetanus, acellular pertussis (whooping cough), <i>Haemophilus influenzae</i> type b, inactivated poliomyelitis (polio) (hepB-DTPa-Hib-IPV)</li> <li>Pneumococcal conjugate (13vPCV)</li> <li>Rotavirus</li> </ul>             |
| <b>4 months</b>                                                                                                      | <ul style="list-style-type: none"> <li>Hepatitis B, diphtheria, tetanus, acellular pertussis (whooping cough), <i>Haemophilus influenzae</i> type b, inactivated poliomyelitis (polio) (hepB-DTPa-Hib-IPV)</li> <li>Pneumococcal conjugate (13vPCV)</li> <li>Rotavirus</li> </ul>             |
| <b>6 months</b>                                                                                                      | <ul style="list-style-type: none"> <li>Hepatitis B, diphtheria, tetanus, acellular pertussis (whooping cough), <i>Haemophilus influenzae</i> type b, inactivated poliomyelitis (polio) (hepB-DTPa-Hib-IPV)</li> <li>Pneumococcal conjugate (13vPCV)</li> <li>Rotavirus<sup>b</sup></li> </ul> |
| <b>12 months</b>                                                                                                     | <ul style="list-style-type: none"> <li><i>Haemophilus influenzae</i> type b and meningococcal C (Hib-MenC)</li> <li>Measles, mumps and rubella (MMR)</li> </ul>                                                                                                                               |
| <b>18 months</b>                                                                                                     | <ul style="list-style-type: none"> <li>Diphtheria, tetanus, pertussis (whooping cough) (DTPa)</li> <li>Measles, mumps, rubella and varicella (chickenpox) (MMRV)</li> </ul>                                                                                                                   |
| <b>4 years</b>                                                                                                       | <ul style="list-style-type: none"> <li>Diphtheria, tetanus, acellular pertussis (whooping cough) and inactivated poliomyelitis (polio) (DTPa-IPV)</li> </ul>                                                                                                                                  |
| SCHOOL PROGRAMS                                                                                                      |                                                                                                                                                                                                                                                                                               |
| <b>10-15 years</b> (contact your State or Territory Health Department for details)                                   | <ul style="list-style-type: none"> <li>Varicella (chickenpox)<sup>c</sup></li> <li>Human papillomavirus (HPV)<sup>d</sup></li> <li>Diphtheria, tetanus and acellular pertussis (whooping cough) (dTpa)</li> </ul>                                                                             |
| AT-RISK GROUPS                                                                                                       |                                                                                                                                                                                                                                                                                               |
| Aboriginal and Torres Strait Islanders                                                                               |                                                                                                                                                                                                                                                                                               |
| <b>12-18 months</b> (in high risk areas) <sup>e</sup>                                                                | <ul style="list-style-type: none"> <li>Pneumococcal conjugate (13vPCV)</li> </ul>                                                                                                                                                                                                             |
| <b>12-24 months</b> (in high risk areas) <sup>f</sup>                                                                | <ul style="list-style-type: none"> <li>Hepatitis A</li> </ul>                                                                                                                                                                                                                                 |
| <b>6 months to less than 5 years</b>                                                                                 | <ul style="list-style-type: none"> <li>Influenza (flu)</li> </ul>                                                                                                                                                                                                                             |
| <b>15 years and over</b>                                                                                             | <ul style="list-style-type: none"> <li>Influenza (flu)</li> <li>Pneumococcal polysaccharide (23vPPV) (medically at risk)</li> </ul>                                                                                                                                                           |
| <b>50 years and over</b>                                                                                             | <ul style="list-style-type: none"> <li>Pneumococcal polysaccharide (23vPPV)</li> </ul>                                                                                                                                                                                                        |
| Other at-risk groups                                                                                                 |                                                                                                                                                                                                                                                                                               |
| <b>6 months and over</b> (people with medical conditions placing them at risk of serious complications of influenza) | <ul style="list-style-type: none"> <li>Influenza (flu)</li> </ul>                                                                                                                                                                                                                             |
| <b>12 months</b> (medically at risk) <sup>e</sup>                                                                    | <ul style="list-style-type: none"> <li>Pneumococcal conjugate (13vPCV)</li> </ul>                                                                                                                                                                                                             |
| <b>4 years</b> (medically at risk) <sup>e</sup>                                                                      | <ul style="list-style-type: none"> <li>Pneumococcal polysaccharide (23vPPV)</li> </ul>                                                                                                                                                                                                        |
| <b>Pregnant women</b> (at any stage of pregnancy)                                                                    | <ul style="list-style-type: none"> <li>Influenza (flu)</li> </ul>                                                                                                                                                                                                                             |
| <b>65 years and over</b>                                                                                             | <ul style="list-style-type: none"> <li>Influenza (flu)</li> <li>Pneumococcal polysaccharide (23vPPV)</li> </ul>                                                                                                                                                                               |
| <b>70 years</b> (a free single catch-up dose is available for adults aged <b>71-79 years</b> until October 2021)     | <ul style="list-style-type: none"> <li>Herpes Zoster (shingles)</li> </ul>                                                                                                                                                                                                                    |

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## FOOTNOTES TO THE NATIONAL IMMUNISATION PROGRAM (NIP) SCHEDULE

- a. Hepatitis B vaccine: should be given to all infants as soon as practicable after birth. The greatest benefit is if given within 24 hours, and must be given within 7 days.
- b. Rotavirus vaccine: third dose of vaccine is dependent on vaccine brand used. Contact your State or Territory Health Department for details.
- c. Varicella vaccine: contact your State or Territory Health Department for details on the school grade eligible for vaccination.
- d. HPV vaccine: is for all adolescents aged between 12 and 13 years. Contact your State or Territory Health Department for details on the school grade eligible for vaccination.
- e. Pneumococcal vaccine:
  - i. Medically at risk children require a fourth dose of 13vPCV at 12 months of age and a booster dose of 23vPPV at 4 years of age.
  - ii. Aboriginal and Torres Strait Islander children require a fourth dose of pneumococcal vaccine (13vPCV) at 12-18 months of age for children living in high risk areas (Queensland, Northern Territory, Western Australia and South Australia). Contact your State or Territory Health Department for details.
- f. Hepatitis A vaccine: two doses of Hepatitis A vaccine for Aboriginal and Torres Strait Islander children living in high risk areas (Queensland, Northern Territory, Western Australia and South Australia). Contact your State or Territory Health Department for details.

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Department of Health (November 2016). *National Immunisation Program Schedule*. Retrieved from [www.immunise.health.gov.au](http://www.immunise.health.gov.au) on 24 January 2017.

## FURTHER INFORMATION

Further information and immunisation resources are available from the Immunise Australia Program website at [www.immunise.health.gov.au](http://www.immunise.health.gov.au) or by contacting the infoline on **1800 671 811**.

You should contact your State or Territory Health Department for further information on the program specific to your State or Territory:

| State/territory              | Contact number        |
|------------------------------|-----------------------|
| Australian Capital Territory | (02) 6205 2300        |
| New South Wales              | 1300 066 055          |
| Northern Territory           | (08) 8922 8044        |
| Queensland                   | 13 HEALTH (13 432584) |
| South Australia              | 1300 232 272          |
| Tasmania                     | 1800 671 738          |
| Victoria                     | 1300 882 008          |
| Western Australia            | (08) 9321 1312        |

# IMMUNISATION RATES FOR VACCINES IN THE NATIONAL SCHEDULE

STATISTICS FROM THE **AUSTRALIAN INSTITUTE OF HEALTH AND WELFARE**

## IMMUNISATION RATES FOR VACCINES IN THE NATIONAL SCHEDULE (CHILDREN)

**D**efinition: The proportion of 1, 2 and 5 year olds who have been assessed as fully immunised according to the Australian Childhood Immunisation Register.

- The immunisation rate for 1 year olds increased from 1999 to 2001 and remained relatively stable from then to 2012. The slight fall in the rate for 2013 and 2014 may have been due to a change in the definition of 'fully immunised' in 2013. The rate was 92% in 2015.

*The immunisation rate for 5 year olds has continued to increase, from 74% in 2005 to 93% in 2015. Children who have had catch-up immunisations are included as 'fully immunised' even if they were not fully immunised when they were 1 or 2 years old.*

- For 2 year olds, the immunisation rate increased markedly from 1999 to 2004, and remained relatively stable at 92% to 93% until 2013. The rate has fallen to 89% in 2015. Changes in the definition of 'fully immunised', implemented in 2014, may have contributed to this drop.
- The immunisation rate for 5 year olds has

continued to increase, from 74% in 2005 to 93% in 2015. Children who have had catch-up immunisations are included as 'fully immunised' even if they were not fully immunised when they were 1 or 2 years old.

- For indigenous children in 2015, the immunisation rate for 1 and 2 year olds was lower than the rate for all children (89% compared with 92% for 1 year olds and 86% compared with 89% for 2 year olds); but the immunisation rate for indigenous 5 year olds was higher than the rate for all children (94% compared with 93%).

## IMMUNISATION RATES FOR VACCINES IN THE NATIONAL SCHEDULE (OLDER PEOPLE)

**D**efinition: Proportion of people aged 65 and over who have been vaccinated for influenza and pneumococcal disease.

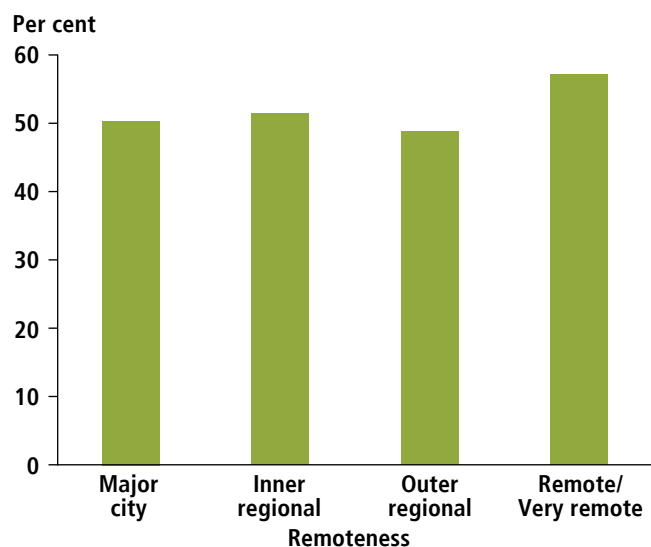
- In 2009, 51% of Australian adults aged 65 and over reported they were immunised against pneumococcal disease and influenza.
- Vaccination rates for influenza and pneumococcal disease were highest in Remote and Very remote areas (57%) but generally similar for Major cities (50%), Inner regional (52%) and Outer regional areas (49%).
- Between 2006 and 2009, vaccination rates for

**FIGURE 7.1.23: IMMUNISATION RATES FOR VACCINES IN THE NATIONAL SCHEDULE, CHILDREN AGED 1, 2 AND 5, 1999 TO 2015**



Source: Australian Childhood Immunisation Register.

**FIGURE 7.1.24: ADULTS AGED 65 AND OVER VACCINATED AGAINST INFLUENZA AND PNEUMOCOCCAL DISEASE, BY REMOTENESS AREA, 2009**



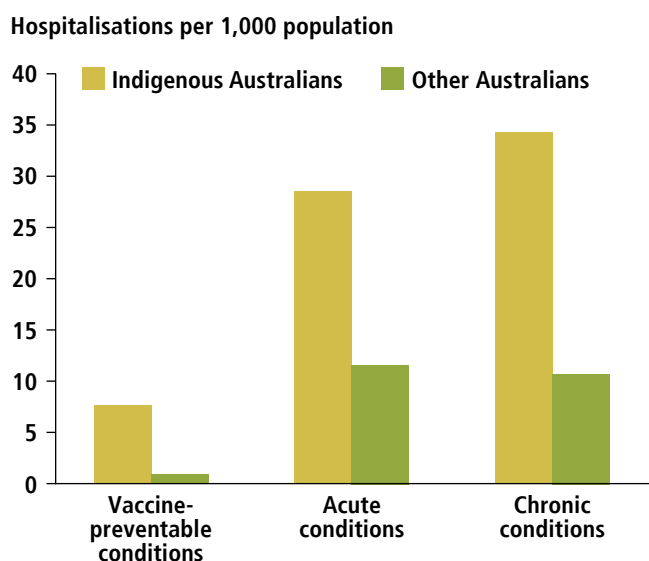
Source: AIHW 2009 Adult Vaccination Survey.

influenza and pneumococcal disease fell among those aged 65 and over, from 59% to 51%.

## SELECTED POTENTIALLY PREVENTABLE HOSPITALISATIONS

**D**efinition: Hospitalisations thought to have been avoidable if timely and adequate non-hospital care had been provided, either to prevent the condition occurring, or to prevent the hospitalisation for the condition. They are categorised as Vaccine-preventable conditions (for example, measles); Acute conditions (for example, ear, nose and throat infections); and Chronic conditions (such as diabetes

**FIGURE 7.1.25: AGE-STANDARDISED RATES OF SELECTED POTENTIALLY PREVENTABLE HOSPITALISATIONS, BY INDIGENOUS STATUS, 2013-14**



Source: AIHW National Hospital Morbidity Database.

complications).

Note that there have been recent changes to this indicator specification, meaning data presented here are not directly comparable with data reported in previous editions of *Australia's health*.

- In 2013-14 there were an estimated 24 potentially preventable hospitalisations per 1,000 population. This rate has decreased slightly since 2007-08 (from 26 hospitalisations per 1,000 population); however, the data may have been affected by changes in classification and reporting over time.
- Potentially preventable hospitalisations accounted for 6.2% of all hospitalisations (8.1% of hospitalisations in public hospitals and 3.4% of hospitalisations in private hospitals).
- The rate of potentially preventable hospitalisations for Indigenous Australians was almost 3 times the rate for other Australians.

*In 2009, 51% of Australian adults aged 65 and over reported they were immunised against pneumococcal disease and influenza.*

- Acute and Chronic conditions were the most common reasons for potentially preventable hospitalisations, at 12 and 11 hospitalisations per 1,000 population respectively. Vaccine-preventable conditions occurred at a rate of 1.3 per 1,000 population.
- Urinary tract infections (24%) and Dental conditions (22%) accounted for almost half of the Acute conditions that were considered potentially preventable, while Chronic obstructive pulmonary disease (22%) and Congestive cardiac failure (19%) were the most common Chronic conditions. Pneumonia and vaccine-preventable influenza accounted for 38% of Vaccine-preventable conditions.

Australian Institute of Health and Welfare (2016). *Australia's health 2016*, pp. 413-415. Retrieved from [www.aihw.gov.au](http://www.aihw.gov.au) on 14 September 2016.

# VACCINATION OBJECTION RATES AREN'T SKYROCKETING

PARENTS ARE SENSITIVE TO WHAT THEY HEAR ABOUT VACCINES,  
OBSERVE **JULIE LEASK** AND **FRANK BEARD**

There has always been a group of people who reject vaccination. They were seen 200 years ago when Edward Jenner developed the smallpox vaccine and they persist today.

But, in recent years, commentators have lamented the apparent growth of this phenomenon. Australians have been warned about a sixfold rise in vaccine objection rates.

This has been used to justify policies such as the federal government's No Jab No Pay. Vaccine objectors can no longer seek exemptions allowing them to receive family assistance payments if their children aren't fully vaccinated.

Parents are sensitive to what they hear about vaccines: from doctors and other health professionals, their families and communities, in the news and online. And the rejection of vaccines can have serious consequences.

However, new data published today in the *Medical Journal of Australia* challenge some of the assumptions about vaccine refusal. We and our colleagues found that overall rates of vaccine objection have remained largely unchanged since 2001.

Parents are sensitive to what they hear about vaccines: from doctors and other health professionals, their families and communities, in the news and online. And the rejection of vaccines can have serious consequences.

We also found that while vaccine objection is a significant problem, it's not the only barrier to our kids being protected against diseases such as measles, polio and diphtheria.

## Child immunisation and conscientious objection

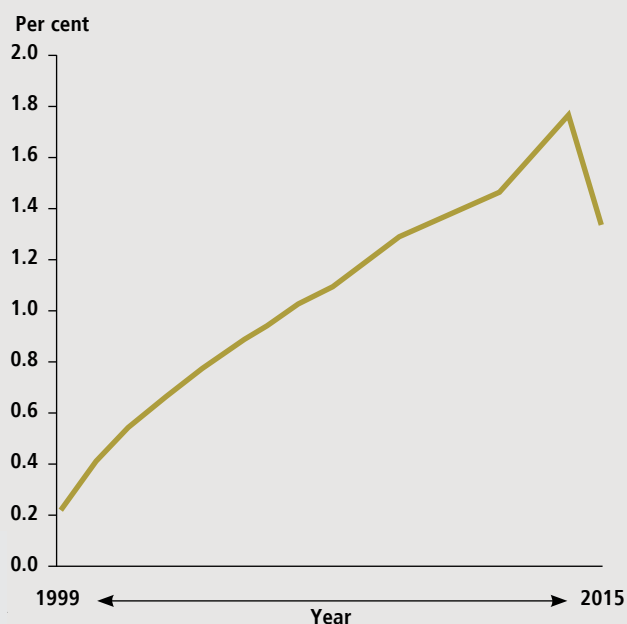
As at December 2015, 92.6% of Australian children were fully immunised by the time they started school. Rates among indigenous children were slightly higher at 93.9% (Department of Health 2016a, 2016b).

While vaccination rates have increased since the Australian Childhood Immunisation Register was established in 1996, vaccine objection rates for children under the age of 7 have also increased steadily, especially under the 'conscientious objector' category.

However, between 2014 and 2015, for the first time since 1999, national vaccine objection rates have decreased (from 1.8% to 1.3%) (Department of Health 2016c).

In 2015, more than 1.3% (equivalent to 30,000) children aged under 7 were not vaccinated because their parents were vaccine objectors (Figure 5.3.1). This equates to an increase of more than 13,000 children over 10 years. In order to protect children and the community from preventable diseases, the Australian Government will remove 'conscientious objection' as an exemption category for childcare payments from 1 January 2016. See 'Chapter 6.1 Prevention and health promotion' and 'Chapter 7.1 Indicators of Australia's health'.

**FIGURE 5.3.1: PROPORTION OF AUSTRALIAN CHILDREN WITH CONSCIENTIOUS OBJECTION RECORDED, 1999-2015**



Australian Institute of Health and Welfare (2016).  
*Australia's Health 2016*, p.204. Retrieved from  
[www.aihw.gov.au](http://www.aihw.gov.au) on 14 September 2016.

Source: Department of Health 2016c.

## Child vaccination rates up since introduction of 'no jab, no pay'

- The Federal Government is claiming early success with its 'no jab, no pay' policy which has led to an extra 5,700 children in the first 6 months of 2016 being vaccinated since its implementation at the start of the year.
- 5,738 children whose parents had previously been listed as vaccination objectors had now been immunised; more than 148,000 children who previously had not been up to date with their vaccinations had also been immunised again.
- The policy involves the withholding of family payments worth up to \$15,000 per year to parents who fail to have their children vaccinated.
- Parents who conscientiously object to vaccination for philosophical or religious reasons are also not able to collect the payments.
- Children with medical reasons for not getting immunised are exempt.
- Since the policy was introduced in January 2016, the immunisation rate for one and five year olds has now reached 93 per cent, up from around 90 per cent when the plan passed Federal Parliament.
- Vaccination rates had fallen to such an historically low level, that Australia was experiencing the re-emergence of diseases the nation had been free of for years, according to Social Services Minister Christian Porter.

Source: Doran, M (31 July 2016), 'Vaccination rates in children up since 'no jab, no pay' introduced, Federal Government says', *ABC News*.

### Rates of objection

Among the broader community, vaccination coverage of young children remained relatively high and stable in the period we studied, 2002 to 2013, at over 90%.

Registered vaccine objection affecting children aged one to six years increased from 1.1% in 2002 to 2.0% in 2013. But our study findings suggest that rates of unrecorded vaccination objection have declined proportionately over this period.

This may be because more parents have become aware that registration of objection preserved eligibility for family assistance payments, which rose in value over this period.

We and our colleagues found that overall rates of vaccine objection have remained largely unchanged since 2001.

Combining the registered and unregistered objection figures, the overall rate in 2013 stands at around 3.3% of children in Australia aged one to six years. This figure is close to that found in the last national survey of parents of incompletely vaccinated children, conducted in 2001.

Registered objectors tend to be clustered more in

regional than metropolitan areas. New South Wales' Richmond Valley had a registered objection rate of 10.8%, while in the Sunshine Coast hinterland 8.5% had a registered objection.

Many people assume that vaccine objectors refuse all vaccines for their children. But nearly half (0.9%) of the 2% with registered objection in our study had at least one vaccine recorded, either before or after vaccine objection was recorded.

So people change their minds: some parents vaccinate their child then register objection; others object then later vaccinate their child. Some always plan to have some vaccines but leave out others.

### Other barriers to vaccination

Vaccine objectors aren't the only ones who forgo vaccination. Another important but often ignored group is those who want to vaccinate their children but face other barriers. This might be due to problems with access to health services, logistical difficulties, other priorities and missed opportunities.

There's also a group with incomplete records who are actually fully vaccinated. This can be due to errors when records are transmitted to the Australian Childhood Immunisation Register, or when they aren't placed on



the register in the first place.

Interestingly, the largest group of children noted in our study with no vaccines recorded at all were those born overseas, who we think have just not had their vaccinations recorded in our register.

These children need to have all their previous vaccines recorded, so that vaccination coverage data is more accurate, catch-up plans, where relevant, are clear, and so they can receive family assistance payments.

Vaccinating children in these groups requires adequate support at government, primary care and community level and that all catch-up vaccines are free.

### Carrot and stick policy responses

The No Jab No Pay legislation amendment of 2016 removed the vaccine exemption that had previously enabled parents, if they objected, to still claim family assistance payments.

But it also expanded the existing penalty when the child turned one, two and five, to a yearly one until the child turns 19. This makes it harder for families – objectors or otherwise – to ignore the much larger financial burden.

For a low-income single-parent household in full-time work, this could be in excess of A\$15,000 per year.

Some commentators have expressed concern at the punitive nature of No Jab No Pay – the stick approach.

But this questionable main course came with some good side dishes. Its promised savings enabled the health department to bring in other measures – the carrots – which would help those other groups get up to date.

These included:

- Incentives for GPs to get overdue children caught up
- Free catch-up vaccines for older children
- Communications that involve a more supportive approach to parents making decisions when they feel hesitant about vaccination.

The best part was the announcement of an expansion of the register to cover the whole of life, so all Australians can more accurately keep track of their vaccinations – due and overdue.

The burning question now is whether No Jab No Pay will have an impact on vaccination rates. The latest vaccination coverage data will be in soon. But for vaccine refusal rates, unfortunately, we no longer have the capacity to measure registered vaccine objection because it has been abolished as an exemption. This is why a full evaluation of the policy is important.

In the longer term, ongoing research of children who aren't up to date on the register will be important to better understand why they aren't vaccinated and direct future efforts.

But if today's new figures provide any hints, No Jab No Pay almost certainly will have impacts. These will be due to a combination of the expanded penalty and the extras that came with it.



Vaccine objectors aren't the only ones who forgo vaccination. Another important but often ignored group is those who want to vaccinate their children but face other barriers. This might be due to problems with access to health services, logistical difficulties, other priorities and missed opportunities.

**Julie Leask** is Associate Professor, University of Sydney.

**Frank Beard** is Senior Lecturer, School of Public Health, University of Sydney.

## THE CONVERSATION

Leask, J, and Beard, F (18 April 2016). *Vaccination objection rates aren't skyrocketing*. Retrieved from <https://theconversation.com> on 13 September 2016.

# Immunisation facts and misconceptions

**BETTER HEALTH CHANNEL** EXPLORES THE FACTS BEHIND THE IMMUNISATION DEBATE

## Summary

- Australian research shows that some parents are concerned about vaccine safety and effectiveness.
- Immunisation reactions are generally mild and resolve by themselves without needing medical treatment.
- The risk of complications from childhood diseases is much higher than the risks from immunisation.

Australian research shows that some parents are concerned about vaccine safety and effectiveness. It is important for parents to understand that the risk of complications from childhood diseases such as measles is much higher than the risk of reactions after immunisation. When parents of young children have had no direct experience of childhood diseases, it is easy to underestimate their effects and complications.

## Immunisation and the immune system

**Myth:** The body's immune system can cope with infection without the help of vaccines.

**Fact:** The immune system is a collection of specialised cells and chemicals that fight infection. Each time an infectious bacterium, fungus or virus (germ) is overcome, the immune system 'remembers' how to defeat that particular infection. If the immune system comes into contact with that particular infectious germ again, it can

destroy it quickly, often before the person even notices any symptoms of illness.

Without causing infection, vaccines trick the immune system into responding as if the body is under attack from a specific bacterium or virus by introducing:

- Dead or weakened versions of the germ
- Inactivated toxins from germs
- Molecules from the surface of the germ.

If the immune system encounters the live germ or toxin later, the immune system quickly recognises it and kills it.

*It is important for parents to understand that the risk of complications from childhood diseases such as measles is much higher than the risk of reactions after immunisation.*

## Immunisation and the infant immune system

**Myth:** The immune systems of babies are protected through the placenta and breastfeeding, so they don't need vaccination.

**Fact:** Babies are exposed to many germs as part of the normal birthing process, including those from the vaginal canal, faeces and breast milk. Although their immune systems can meet these challenges, the immune system in an infant is still developing and needs to



become active to protect against a range of bacteria and viruses.

An infant will receive some natural protection against diseases transferred from the placenta, but the level of protection depends on the mother's exposure to disease either by illness or vaccination. Breastmilk is also valuable for protection, but the protection is mainly for germs that infect the gut. The protection received from the placenta and breastmilk can be weak and only lasts for a few months.

### Immunisation and immunity

**Myth:** Combining two or three vaccines into one injection may put a baby's immune system under considerable strain. Vaccines should be separated and given at six-monthly or yearly intervals.

**Fact:** Delaying vaccines would leave children vulnerable to catching diseases. Vaccines do not reduce a child's immunity. Combining vaccines reduces the number of injections that babies and children need to receive.

Vaccine preparations don't cause infection, so an 'all-out' immune response is not triggered. In addition, the immune system is designed to handle multiple attacks, because in nature germs don't attack the body one at a time.

Each vaccine is carefully researched and produced so that it is suitable to be given at the earliest possible time to provide the best level of effectiveness and protection.

### Immunisation and vaccine safety

**Myth:** Vaccines cause side effects and should be avoided.

**Fact:** Vaccines provide a safe and efficient way to prevent the spread of many communicable diseases. Every vaccine used in Australia has been thoroughly tested for safety and effectiveness, approved for use by the Therapeutic Goods Administration (TGA) and is subject to ongoing monitoring and evaluation. However, vaccines are like any other medication and they may trigger side effects but these are mostly mild. This is why parents are generally advised to remain at the clinic for at least 15 minutes after their children are immunised. In the majority of cases, side effects are mild.

### Immunisation and autism, diabetes and sudden unexpected death in infancy

**Myth:** Vaccinations can cause certain disorders, such as autism and diabetes, or contribute to the risk of sudden unexpected death in infancy (SUDI), which includes sudden infant death syndrome (SIDS) and fatal sleep accidents.

**Fact:** These theories have been extensively investigated and dismissed. Immunisation reactions are generally mild and resolve by themselves without needing medical treatment. Reactions may include fever and soreness at the injection site. Serious immunisation reactions are exceptionally rare. Watch a video showing Telethon Kids autism researcher Professor Andrew Whitehouse talk about vaccination and autism at <https://vimeo.com/155754242>

### Immunisation versus the risk of childhood diseases

**Myth:** Immunisation for childhood infectious disease is riskier than the disease.

**Fact:** Childhood diseases such as measles and whooping cough (pertussis) are serious and potentially fatal. The risk of complications from disease is much higher than the risks of complications from immunisation.

Parents who are fearful of autism, SUDI or other disease complications may choose not to have their children vaccinated. However, if vaccination levels in the community fall too low, disease epidemics can reappear. People with little first-hand experience of childhood infectious disease can underestimate the effects and complications of infectious diseases.

Some parents worry that the measles mumps rubella (MMR) vaccine can cause brain inflammation (encephalitis), but this risk for the vaccine is around one in one million. On the other hand, one in every 1,000 children who catch measles will experience encephalitis. Of these, one in 10 will die and four in 10 will have permanent brain damage.

### The effectiveness of immunisation

**Myth:** It is not worth immunising children because vaccines don't work.

**Fact:** It is true that some people still catch a disease even though they have been vaccinated against it. In some cases, even if people do catch the disease after vaccination, their symptoms can be far less severe if they have been vaccinated. No vaccine can offer complete immunity against disease for everyone.

Examples of vaccine effectiveness include:

- Diphtheria – 84 out of every 100 people vaccinated will be completely immune
- *Haemophilus influenzae* type b (hib) – 95 out of every 100 people vaccinated will be completely immune
- Measles, mumps, rubella – 95 out of every 100 people vaccinated will be completely immune
- Whooping cough – about 85 out of every 100 people vaccinated will be completely immune
- Polio – 95 out of every 100 people vaccinated will be completely immune.

*When parents of young children have had no direct experience of childhood diseases, it is easy to underestimate their effects and complications.*

### Immunisation and HALO

The immunisations you may need are decided by your health, age, lifestyle and occupation. Together, these factors are referred to as HALO.

Talk to your doctor or immunisation provider if you think you or someone in your care has health, age, lifestyle or occupation factors that could mean



immunisation is necessary. You can check your immunisation HALO using the Immunisation for Life infographic (pdf) downloadable poster, available at: [www.betterhealth.vic.gov.au/~media/bhc/files/campaign/halo/halo-poster-2016.pdf?la=en](http://www.betterhealth.vic.gov.au/~media/bhc/files/campaign/halo/halo-poster-2016.pdf?la=en)

### Where to get help

- Your doctor
- In an emergency, always call triple zero (000)
- Emergency department of your nearest hospital
- Your local government immunisation service
- Maternal and Child Health Line (24 hours) Tel. 132 229
- NURSE-ON-CALL Tel. 1300 60 60 24 – for expert health information and advice (24 hours, 7 days)
- Immunisation Program, Department of Health & Human Services, Victorian Government Tel. 1300 882 008
- National Immunisation Information Line Tel. 1800 671 811
- Your local pharmacist
- SAEFVIC Tel. 1300 882 924 – the line is attended between 10am and 3.30pm and you can leave a message at all other times.

### Things to remember

- Australian research shows that some parents are concerned about vaccine safety and effectiveness.
- Immunisation reactions are generally mild and resolve by themselves without needing medical treatment.

- The risk of complications from childhood diseases is much higher than the risks from immunisation.

### References

- *What are some of the myths – and facts – about vaccination?*, 2013, World Health Organization.
- *Immunisation – Protecting our children from disease*, 2012, Australian Academy of Science.
- *Immunisation myths and realities. Responding to arguments against immunisation. A guide for providers*, 5th edition, 2013, Department of Health, Australian Government.
- *The Australian Immunisation Handbook 10th Edition*, 2013, Department of Health, Australian Government.
- *Immunisation schedule Victoria*, from June 2015, Department of Health and Human Services, Victorian Government.
- *National Immunisation Program Schedule*, from 20 April 2015, Department of Health, Australian Government.
- *Vaccine side effects*, 2013, Department of Health and Human Services, Victorian Government.
- *Pre-immunisation checklist – what to tell your doctor or nurse before immunisation*, 2013, Department of Health, Victorian Government.

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Better Health Channel. *Immunisation facts and misconceptions*.

Last updated December 2015. Retrieved from

[www.betterhealth.vic.gov.au](http://www.betterhealth.vic.gov.au) on 13 September 2016.

# WHAT ARE SOME OF THE MYTHS – AND FACTS – ABOUT VACCINATION?

Questions and answers explained by the **World Health Organization**

**Myth 1: Better hygiene and sanitation will make diseases disappear – vaccines are not necessary. FALSE**

**Fact 1:** The diseases we can vaccinate against will return if we stop vaccination programmes. While better hygiene, hand washing and clean water help protect people from infectious diseases, many infections can spread regardless of how clean we are. If people are not vaccinated, diseases that have become uncommon, such as polio and measles, will quickly reappear.

**Myth 2: Vaccines have several damaging and long-term side effects that are yet unknown. Vaccination can even be fatal. FALSE**

**Fact 2:** Vaccines are very safe. Most vaccine reactions are usually minor and temporary, such as a sore arm or mild fever. Serious health events are extremely rare and are carefully monitored and investigated. You are far more likely to be seriously injured by a vaccine-preventable disease than by a vaccine. For example, in the case of polio, the disease can cause paralysis, measles can cause encephalitis and blindness, and some vaccine-preventable diseases can even result in death. While any serious injury or death caused by vaccines is one too many, the benefits of vaccination greatly outweigh the risk, and many more injuries and deaths would occur without vaccines.

**Myth 3: The combined vaccine against diphtheria, tetanus and pertussis (whooping cough) and the vaccine against poliomyelitis cause sudden infant death syndrome. FALSE**

**Fact 3:** There is no causal link between the administering of the vaccines and sudden infant death, however, these vaccines are administered at a time when babies can suffer sudden infant death syndrome (SIDS). In other words, the SIDS deaths are co-incidental to vaccination and would have occurred even if no vaccinations had been given. It is important to remember that these four diseases are life-threatening and babies who are not vaccinated against them are at serious risk of death or serious disability.

**Myth 4: Vaccine-preventable diseases are almost eradicated in my country, so there is no reason to be vaccinated. FALSE**

**Fact 4:** Although vaccine-preventable diseases have become uncommon in many countries, the infectious agents that cause them continue to circulate in some parts of the world. In a highly inter-connected world, these agents can cross geographical borders and infect anyone who is not protected. In western

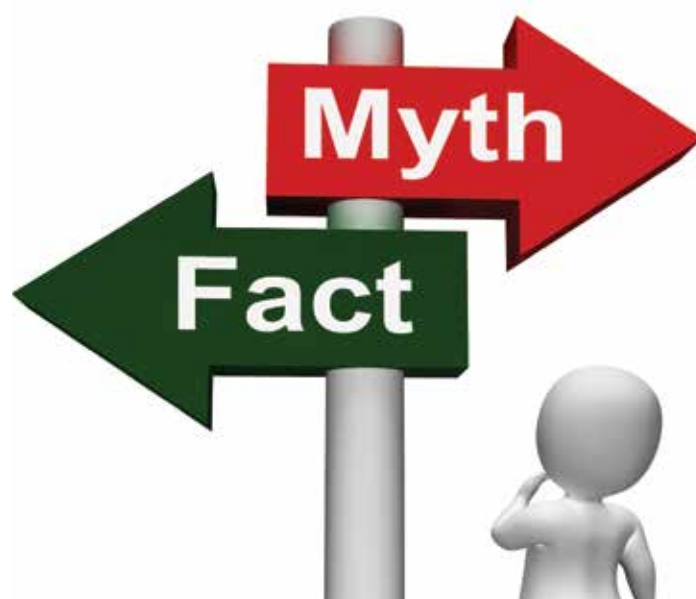
Europe, for example, measles outbreaks have occurred in unvaccinated populations in Austria, Belgium, Denmark, France, Germany, Italy, Spain, Switzerland and the United Kingdom since 2005. So two key reasons to get vaccinated are to protect ourselves and to protect those around us. Successful vaccination programmes, like successful societies, depend on the cooperation of every individual to ensure the good of all. We should not rely on people around us to stop the spread of disease; we, too, must do what we can.

**Myth 5: Vaccine-preventable childhood illnesses are just an unfortunate fact of life. FALSE**

**Fact 5:** Vaccine-preventable diseases do not have to be 'facts of life'. Illnesses such as measles, mumps and rubella are serious and can lead to severe complications in both children and adults, including pneumonia, encephalitis, blindness, diarrhoea, ear infections, congenital rubella syndrome (if a woman becomes infected with rubella in early pregnancy), and death. All these diseases and suffering can be prevented with vaccines. Failure to vaccinate against these diseases leaves children unnecessarily vulnerable.

**Myth 6: Giving a child more than one vaccine at a time can increase the risk of harmful side effects, which can overload the child's immune system. FALSE**

**Fact 6:** Scientific evidence shows that giving several vaccines at the same time has no adverse effect on a child's immune system. Children are exposed to several hundred foreign substances that trigger an immune





response every day. The simple act of eating food introduces new antigens into the body, and numerous bacteria live in the mouth and nose. A child is exposed to far more antigens from a common cold or sore throat than they are from vaccines. Key advantages of having several vaccines at once is fewer clinic visits, which saves time and money, and children are more likely to complete the recommended vaccinations on schedule. Also, when it is possible to have a combined vaccination, e.g. for measles, mumps and rubella, that means fewer injections.

**Myth 7: Influenza is just a nuisance, and the vaccine isn't very effective. FALSE**

**Fact 7:** Influenza is much more than a nuisance. It is a serious disease that kills 300,000-500,000 people worldwide every year. Pregnant women, small children, elderly people with poor health and anyone with a chronic condition, like asthma or heart disease, are at higher risk for severe infection and death. Vaccinating pregnant women has the added benefit of protecting their newborns (there is currently no vaccine for babies under six months). Most of influenza vaccines offer immunity to the three most prevalent strains circulating in any given season. It is the best way to reduce your chances of severe flu and of spreading it to others. Avoiding the flu means avoiding extra medical care costs and lost income from missing days of work or school.

**Myth 8: It is better to be immunised through disease than through vaccines. FALSE**

**Fact 8:** Vaccines interact with the immune system to produce an immune response similar to that produced

by the natural infection, but they do not cause the disease or put the immunised person at risk of its potential complications. In contrast, the price paid for getting immunity through natural infection might be mental retardation from *Haemophilus influenzae* type b (Hib), birth defects from rubella, liver cancer from hepatitis B virus, or death from measles.

**Myth 9: Vaccines contain mercury which is dangerous. FALSE**

**Fact 9:** Thimerosal is an organic, mercury-containing compound added to some vaccines as a preservative. It is the most widely-used preservative for vaccines that are provided in multi-dose vials. There is no evidence to suggest that the amount of thimerosal used in vaccines poses a health risk.

**Myth 10: Vaccines cause autism. FALSE**

**Fact 10:** The 1998 study which raised concerns about a possible link between measles-mumps-rubella (MMR) vaccine and autism was later found to be seriously flawed, and the paper has been retracted by the journal that published it. Unfortunately, its publication set off a panic that led to dropping immunisation rates, and subsequent outbreaks of these diseases. There is no evidence of a link between MMR vaccine and autism or autistic disorders.

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World Health Organization (March 2016). *What are some of the myths – and facts – about vaccination*. Retrieved from [www.who.int](http://www.who.int) on 12 September 2016.

# Get the flu shot before the flu gets you

## CONSUMER FACT SHEET FROM THE DEPARTMENT OF HEALTH

- Vaccination is the single most effective way of preventing the spread of flu in the community.
- If you want to protect yourself from the flu, get vaccinated every year because the flu virus is constantly changing.
- The flu vaccine is available free under the National Immunisation Program from April 2016 for those people who have the greatest risk of becoming severely ill from flu.
- Flu vaccines are age-specific, so parents should tell their doctor the age of their child before vaccinating.

### What is the flu?

**I**nfluenza (flu) is a highly contagious viral infection that spreads easily from person to person through coughing, sneezing and close contact.

The flu virus infects your nose, throat and sometimes your lungs. Unlike a cold, symptoms such as fever, sore throat and muscle aches develop suddenly with flu and last about a week. In some cases, severe illness and complications such as pneumonia and bronchitis can develop, which can result in hospitalisation and even death. The flu can also make some existing medical conditions worse.

### Why should I get the flu shot?

Annual vaccination is the best way of preventing the flu and any associated illness.

You should get the flu shot every year because the flu virus is constantly changing. Every year, the flu vaccine changes too, so it protects against the flu strains which are most likely to be around during that winter.

Being vaccinated in autumn allows time for the vaccine to work before the flu season starts and offers protection throughout the winter months. Even if you received a flu shot towards the end of the last flu season, you should still be vaccinated again before this flu season.

The flu vaccine does not contain any live virus, so you cannot get the flu from the vaccine.

### Who is eligible for the free flu shot?

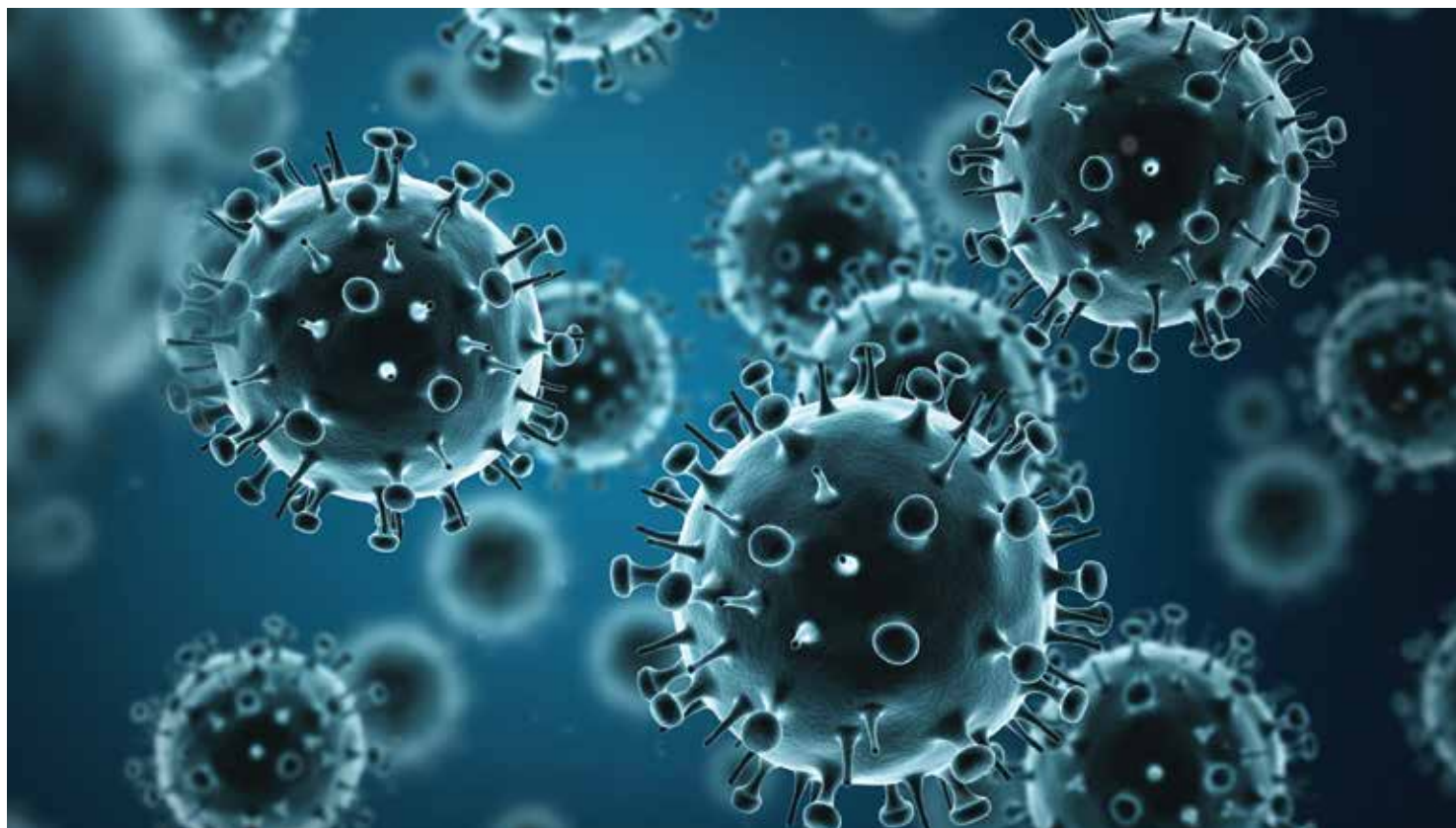
Vaccination experts recommend the flu vaccine for everyone from six months of age, however the vaccine is free under the National Immunisation Program for people at high risk of complications. They are:

#### *Pregnant women*

Pregnant women are at higher risk of severe complications associated with the flu. Vaccinating against flu at any stage during pregnancy is safe and also provides some protection for babies during their first, vulnerable months of life.

#### *Aboriginal and Torres Strait Islander people*

All Aboriginal and Torres Strait Islander people from six months to less than five years of age, and 15 years of age and over, are eligible for free flu shots.



### People 65 years and over

People aged 65 years and over have the highest risk of complications associated with seasonal flu.

### People with certain medical conditions

People with some existing medical conditions are more likely to experience complications from flu.

These include anyone who is six months of age and over who has:

- Heart disease
- Severe asthma
- Chronic lung condition
- Chronic illness requiring medical follow-up or hospitalisation in the past year
- Diseases of the nervous system
- Impaired immunity
- Diabetes
- Children aged six months to 10 years on long-term aspirin therapy.

### Flu vaccine for children

The flu vaccines are age-specific. Make sure your vaccination provider knows how old your child is so they can receive the correct dose and brand of vaccine.

### Flu vaccine safety

Common side effects usually occur within one to two days following flu vaccination and include soreness, redness, pain and swelling at the injection site, drowsiness, tiredness, muscle aches and low-grade fever. If these side effects occur they are usually mild and go away within a few days, usually without any treatment.

There may be a small increase in the risk of fever when a child receives both the flu vaccine and the pneumococcal disease vaccine (Prevenar 13) at the same time. These two vaccines can be given separately, with a least a three-day interval between them, to reduce the likelihood of fever. If you are concerned, you should discuss this option with your doctor or vaccination provider.

You are encouraged to report any adverse event following the flu vaccine to your doctor or vaccination provider, to the Adverse Medicines Events Line on 1300 134 237, or to the Therapeutic Goods Administration (TGA) through the 'Report a problem' link on the TGA website.

### Where can I get the flu shot

Vaccines are available from April 2016 from doctors and other vaccination providers.

### Contact list

State and territory contact numbers:

ACT: 02 6205 2300

NSW: 1300 066 055

NT: 08 8922 8044

WA: 08 9321 1312

SA: 1300 232 272

TAS: 1800 671 738

VIC: 1300 882 008

QLD: 13 HEALTH (13 43 25 84)

For more information about the latest seasonal influenza vaccine, visit [immunise.health.gov.au](http://immunise.health.gov.au) or call the Immunise Australia Information line: 1800 671 811.

A more detailed fact sheet, *Australian Technical Advisory Group on Immunisation (ATAGI) information for individuals and families on the influenza vaccines available in 2016*, is also available on the Immunise Australia website.

All information in this fact sheet is correct as at 22 March 2016 and valid for the 2016 influenza season.

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Department of Health (March 2016). *Get the flu shot before the flu gets you* (Consumer fact sheet). Retrieved from [www.immunise.health.gov.au](http://www.immunise.health.gov.au) on 14 September 2016.



# EXPLORING ISSUES

## WORKSHEETS AND ACTIVITIES

The Exploring Issues section comprises a range of ready-to-use worksheets featuring activities which relate to facts and views raised in this book.

The exercises presented in these worksheets are suitable for use by students at middle secondary school level and beyond. Some of the activities may be explored either individually or as a group.

As the information in this book is compiled from a number of different sources, readers are prompted to consider the origin of the text and to critically evaluate the questions presented.

Is the information cited from a primary or secondary source? Are you being presented with facts or opinions?

Is there any evidence of a particular bias or agenda? What are your own views after having explored the issues?

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Brainstorm, individually or as a group, to find out what you know about infectious diseases.

**1. What is a communicable disease, and what are some examples?**

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**2. What is immunisation, and why is it required?**

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**3. Explain the difference between the terms 'epidemic' and 'pandemic'?**

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**4. What is antimicrobial resistance, and why is it a concern?**

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In groups of two or more people in your class, write a design brief for a poster to promote ways in which people can contribute to reducing the spread of infectious diseases in their local community.

**In the brief, explain why it is important to reduce infectious diseases and present a list of the types of behaviours people can adopt. Also briefly explain the major types of diseases whose spread can be reduced by adopting these behaviours. Include suggestions for text and images to maximise the impact of your public health message. Share your ideas with other groups in the class.**

This image shows a full page of blank white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.



*“Vaccination is one of the most successful and cost-effective population health interventions. It can protect individuals from life-threatening diseases, and also reduces transmission in the community.”*

[illegible]



## MULTIPLE CHOICE

Complete the following multiple choice questionnaire by circling or matching your preferred responses. The answers are at the end of the following page.

- 1. As a result of the pioneering work of Dr Edward Jenner, when did the modern era of vaccination begin?**
  - a. 16th century
  - b. 17th century
  - c. 18th century
  - d. 19th century
  - e. 20th century
  - f. 21st century
  
- 2. Microorganisms that develop antimicrobial resistance are sometimes referred to as which of the following?**
  - a. Superviruses
  - b. Antibugs
  - c. Bacteria
  - d. Megamicrobes
  - e. Viruses
  - f. Parasites
  - g. Superbugs
  
- 3. The human disease caused by the Zika virus was first identified in what year?**
  - a. 1914
  - b. 1936
  - c. 1954
  - d. 1976
  - e. 1994
  - f. 2016
  
- 4. Ebola first emerged in the Democratic Republic of the Congo in what year?**
  - a. 1914
  - b. 1936
  - c. 1954
  - d. 1976
  - e. 1994
  - f. 2016
  
- 5. Which of the following are examples of airborne-spread diseases? (select all that apply)?**
  - a. Rubella
  - b. Measles
  - c. Scabies
  - d. Hepatitis B
  - e. Tuberculosis
  - f. Chickenpox
  - g. Rabies
  - h. Dengue fever



## MULTIPLE CHOICE

### 6. Respond to the following statements by circling either 'True' or 'False':

- |                                                                                                                                                                                                       |      |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|
| a. There are no effective vaccines against tuberculosis, malaria and HIV.                                                                                                                             | True | False |
| b. The widespread use of antibiotics has contributed to the elimination of superbugs.                                                                                                                 | True | False |
| c. Some bacteria are good for you, offering protection against pathogens and aiding with digestion in the gut.                                                                                        | True | False |
| d. Most Australians who contract HIV will get AIDS.                                                                                                                                                   | True | False |
| e. Nearly 60% of bugs that infect humans originated in animals.                                                                                                                                       | True | False |
| f. Around the time that Chinese paediatrician Wan Quan (1495-1585) identified smallpox, the Chinese began 'immunising' healthy subjects by blowing powdered smallpox scab material up people's noses. | True | False |

### 7. Match the following diseases to their correct definition:

- |                         |                                                                                                                                                                                                                  |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a. Measles              | 1. The most common viral infection of the reproductive tract, which can cause cervical cancer, other types of cancer, and genital warts in both men and women.                                                   |
| b. Rubella              | 2. Caused by a bacterium which grows in the absence of oxygen, for example in dirty wounds or in the umbilical cord if it is not kept clean. It produces a toxin which can cause serious complications or death. |
| c. Hepatitis B          | 3. The most deadly disease caused by parasites.                                                                                                                                                                  |
| d. Influenza            | 4. A highly infectious viral disease that can cause irreversible paralysis.                                                                                                                                      |
| e. Polio                | 5. A viral disease, usually mild in children, but infection during early pregnancy may cause foetal death or can lead to defects of the brain, heart, eyes and ears.                                             |
| f. Meningitis A         | 6. A highly contagious disease caused by a virus, which usually results in a high fever and rash, and can lead to blindness, encephalitis or death.                                                              |
| g. Tetanus              | 7. An infection that can cause severe brain damage and is often deadly.                                                                                                                                          |
| h. Rotaviruses          | 8. The most common cause of severe diarrhoeal disease in young children throughout the world.                                                                                                                    |
| i. Human papillomavirus | 9. A viral infection that attacks the liver.                                                                                                                                                                     |
| j. Malaria              | 10. A highly contagious viral infection that infects the upper airways and lungs and spreads easily from person to person through coughing, sneezing and close contact.                                          |

## MULTIPLE CHOICE ANSWERS

1 - c; 2 - g; 3 - d; 4 - b; 5 - e; 6 - f; 7 - a; 8 - i; 9 - d; 10 - e = 4, f = 7, g = 2, h = 8, i = 1, j = 3. suppresses HIV before it ever develops into AIDS), e = 1, f = 7, a = 8, b = 5, c = 9, d = 10, e = 4, f = 7, g = 2, h = 8, i = 1, j = 3. Australians who contract HIV today will never get AIDS due to the effective and consistent use of antiretroviral treatment (ART) which the time antibiotics are not prescribed properly and are sometimes consumed when our bodies do not even need them), c = 1, d = f (most of superbugs; about 50% of

- Germs can enter the body through the: mouth, respiratory tract, eyes, genitals, and broken skin (SA Health, *Ways infectious diseases spread*). (p.1)
- Between the period of April 2009 and August 2010, there were approximately 18,449 deaths in over 214 countries from the flu virus (H1N1) (Banerjee, A, *Explainer: what's the difference between an outbreak and an epidemic*). (p.4)
- Dengue, which is spread by mosquitoes, is endemic in more than 100 countries (*ibid*). (p.4)
- Ebola, like other recently emerged diseases, like AIDS in Africa or SARS in Asia, originated in the developing world (Quince, A, *A history of plagues, pandemics and Ebola*). (p.6)
- The first recorded pandemic occurred in the 6th century and is known as the Justinian Plague. It was followed in the 14th century by the Black Death; both are thought to have been caused by the bubonic plague, which is spread by infested fleas that live on infected rats (*ibid*). (p.6)
- The diseases that spread globally during the Middle Ages until the 19th century were smallpox, cholera, and plague. In the late 19th century, yellow fever began spreading in the Americas, and there was fear that it would also become a worldwide disease (*ibid*). (p.7)
- Viruses grow only in living cells. But they infect everything from the simplest, single-cell organisms, such as amoebae, to multicellular, multi-organ ecosystems like us (Doherty, PC, *Disease evolution: our long history of fighting viruses*). (p.10)
- From 430-427 BCE, the Plague of Athens, described by Thucydides, killed more than one-third of the population. The cause is unknown, though the favoured candidate is the bacterial infection typhus (*ibid*). (p.10)
- The 1918-19 H1N1 flu likely 'jumped' from birds to people (or via pigs), while the much less virulent 2009 H1N1 strain clearly originated in pigs to cause the first human pandemic of the 21st century. Mass air travel ensured that it was around the planet in six months (Doherty, PC, *Disease evolution: our long history of fighting viruses*). (p.11)
- Humans have been 'acquiring' infectious diseases from animals since we first started hunting wild game on the African savannahs. Indeed, nearly 60% of bugs that infect humans originated in animals (Reid, S, *Disease evolution: how new illnesses emerge when we change how we live*). (p.12)
- These days, we seem to see more 'new' diseases, such as Zika, Ebola and SARS. But there are plenty more lurking. A recent study suggests there are around 300,000 pathogens we don't even know about and some have the potential to spread from animals to humans (*ibid*). (p.12)
- The natural host of SARS is thought to be bats. But the jump to humans occurred via the palm civet, a small omnivorous mammal. Civets are a delicacy and eating them is a sign of wealth in Cantonese culture. At the time, civets were slaughtered for local consumption at restaurants specialising in wild game. One of the first cases was a cook in Shenzhen (*ibid*). (p.13)
- AIDS is still a major public health problem in other countries – globally, more than 35 million people live with HIV, most of whom live in countries where ART is not readily available or affordable. In 2014 alone, more than 1.2 million people died from AIDS-related illnesses (Power, J, *AIDS epidemic no longer a public health issue, but HIV still is*). (p.15)
- There were an estimated 201,200 respiratory deaths with an additional 83,300 cardiovascular deaths globally during the 2009 influenza (H1N1) pandemic (Banerjee, A, Perez, JB and von Freyend, SJ, *Know your bugs – a closer look at viruses, bacteria, and parasites*). (p.16)
- Thanks to the misuse and overuse of antibiotics, resistant bacteria is on the rise, and as of 2013, there were about 480,000 new cases of multidrug-resistant tuberculosis (*ibid*). (p.16)
- Malaria, which kills one child every 30 seconds with 90% of the cases in Africa, is still the most deadly disease caused by parasites (*ibid*). (p.17)
- Antimicrobial resistant-microbes are found in people, animals, food, and the environment (in water, soil and air). They can spread between people and animals, and from person to person. Poor infection control, inadequate sanitary conditions and inappropriate food-handling encourage the spread of antimicrobial resistance (WHO, *Antimicrobial resistance*). (p.18)
- Coloured mucous or phlegm isn't always a sign of a bacterial infection ... Green or yellow coloured snot can in fact be a sign that your immune system is fighting your infection, and not that your illness is getting worse (NPS Medicinewise, *Antibiotic resistance: The facts*). (p.21)
- Immunisation averts an estimated 2 to 3 million deaths every year from diphtheria, tetanus, pertussis (whooping cough), and measles; however, an additional 1.5 million deaths could be avoided if global vaccination coverage improves (WHO, *Immunization coverage*). (p.25)
- The modern era of vaccination began in the 18th century through the pioneering work of British doctor Edward Jenner (Prasad, S, *Vaccines on the frontline against infectious diseases*). (p.28)
- In Australia, vaccines have had a profound impact in the decades following their introduction. Deaths from diphtheria, pertussis (whooping cough), tetanus, polio and measles have either fallen to zero or close to zero (*ibid*). (p.28)
- Polio is on the brink of being eradicated, with the number of cases worldwide falling by more than 99% since 1988 (*ibid*). (p.29)
- There are no effective vaccines against tuberculosis, malaria and HIV, currently the world's three deadliest infectious diseases (*ibid*). (p.30)
- The majority of Australian children have been fully vaccinated. In 2012 around 92% of 12, 24 and 60 month old children had been fully immunised. These rates have been slowly increasing since 2000 (Lowinger, J, *Fact File: Immunisation*). (p.35)

## **Antibiotic resistance**

A consequence of antibiotic use, which should be minimised and used prudently. Antibiotics should not be used when benefit is minimal, such as in the case of many respiratory tract infections. Narrow spectrum antibiotics should be used whenever possible, and optimal dosages and regimens used where required.

## **Antimicrobial resistance**

Occurs when microorganisms (bacteria, fungi, viruses, and parasites) change when exposed to antimicrobial drugs (such as antibiotics, antifungals, antivirals, antimalarials, and anthelmintics). Microorganisms that develop antimicrobial resistance are sometimes referred to as 'superbugs'. As a result, medicines become ineffective and infections persist in the body, increasing the risk of spread to others.

## **Antiviral**

Type of drug used to help prevent or treat illnesses caused by some viruses, including influenza.

## **Bacteria**

Microorganisms which are smaller than a blood cell but bigger than a virus. Examples of bacterial infections are pertussis, tetanus, diphtheria, Hib and tuberculosis.

## **Carrier**

Person who has an infection which, although not necessarily causing symptoms, may still be active and may spread to others; the carrier state may last for years; an example of infections that can result in the carrier state is hepatitis B.

## **Communicable diseases**

Diseases (including infectious and parasitic diseases) which are capable of being transmitted from one person to another, or from one species to another.

## **Community transmission**

The passing of a disease from an infected individual to another individual outside of a known group of contacts, and outside health care settings.

## **Endemic**

An endemic infection is one which is present all the time in a community.

## **Epidemic**

The occurrence in a community or region of an illness or disease in excess of normal expectancy within a given time period. Small epidemics are often called outbreaks.

## **Epidemiology**

The study of the incidence, prevalence and the cause of disease in populations.

## **Immunisation**

Process of bringing about immunity to a particular infective agent (such as a bacterium or virus) by giving a vaccine. The terms vaccination and immunisation are not exactly the same; vaccination is the process of giving a vaccine, while immunisation is the process of both giving a vaccine and the body developing an immune response as a result of the vaccine.

## **Immunity**

Ability of the body to fight off certain infections. Immunity can result from natural infection or from vaccination.

## **Infection**

Infections occur when bacteria or viruses invade the body; if the body cannot fight infections, they may cause illness.

## **Infectious**

Capable of spreading disease or a disease that is capable of spreading (also known as communicable).

## **Infectious diseases**

Illnesses which are caused by bacteria, parasites, viruses and other agents and which can be passed from person to person, or from insects, birds and animals to humans.

## **Isolation**

Separation, of infected persons (cases) from other people for the period they are likely to be infectious, in order to prevent or limit the direct or indirect transmission of the virus.

## **Outbreak**

An epidemic that is limited to a localised increase in the incidence of a disease, for example, to a town or institution.

## **Pandemic**

A pandemic disease is one which is prevalent throughout an entire country or continent, or the whole world.

## **Strain**

A group of organisms within a species or type that are genetically similar. Influenza viruses are described by their Type (e.g. Type A, B or C), their subtype (e.g. H5N1), and then their strain (e.g. Hong Kong strain).

## **Superbugs**

Superbugs are strong strands of bacteria that often cause common gut, urinary and blood infections, but become dangerous because they are immune to the antibiotics we currently take. Some infections will become incurable unless new antibiotics are created.

## **Vaccination**

The administration of a vaccine. If vaccination is successful, it results in immunity.

## **Vaccine**

A medication that stimulates the production of antibodies to protect against a specific disease.

## **Virulence**

How well or quickly a virus or bacteria is able to cause disease in a person.

## **Virus**

Tiny living organism, smaller than a bacterium, that can cause infections. Measles, rubella, polio, mumps, influenza and hepatitis B are caused by viruses.

## Websites with further information on the topic

Australasian Society for Infectious Diseases [www.asid.net.au](http://www.asid.net.au)  
 Australian Institute of Health and Welfare [www.aihw.gov.au](http://www.aihw.gov.au)  
 Better Health Channel [www.betterhealth.vic.gov.au](http://www.betterhealth.vic.gov.au)  
 Centers for Disease Control and Prevention (US) [www.cdc.gov](http://www.cdc.gov)  
 Communicable Diseases Network Australia (CDNA) [www.health.gov.au/cdna](http://www.health.gov.au/cdna)  
 Department of Health [www.health.gov.au](http://www.health.gov.au)  
 healthdirect – Infectious diseases [www.healthdirect.gov.au/infectious-diseases](http://www.healthdirect.gov.au/infectious-diseases)  
 Immunisation Coalition [www.immunisationcoalition.org.au](http://www.immunisationcoalition.org.au)  
 Immunise Australia Program [www.immunise.health.gov.au](http://www.immunise.health.gov.au)  
 Medical Journal of Australia [www.mja.com.au](http://www.mja.com.au)  
 myDr [www.mydr.com.au](http://www.mydr.com.au)  
 National Centre for Immunisation Research and Surveillance [www.ncirs.edu.au](http://www.ncirs.edu.au)  
 Women's and Children's Health Network [www.cyh.com](http://www.cyh.com)  
 World Health Organization [www.who.int/en/](http://www.who.int/en/)

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