



PERTUSSIS: current epidemiology, diagnosis, and strategies to prevent disease

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Auckland, New Zealand

Is whooping cough (pertussis) really
still such a problem?



I am a paediatrician

The Starship Children's Hospital Auckland New Zealand



I am a paediatrician at the Starship Children's Hospital

I see lots of children with
whooping cough

Whooping cough = pertussis

<http://www.cdc.gov/pertussis/pubs-tools/multimedia.html#pertussis-sounds>

Latin derivation Pertussis: per = excess, tussis = cough

“Whooping” is from the horrible noise that people with this illness make as they desperately try to breathe in

Case 1 Baby girl age 5 weeks

- Born 5 weeks early
- Unwell for 2 weeks with cough
 - More recently poor oral intake
 - Going blue with cough
 - Increased breathing effort 2 days
 - Cough more severe 2 days
- Mother cough 5 weeks, worse at night

Clinical signs on admission

- Weight 2.6 kg (skinny)
- Afebrile
- Cough
 - Not paroxysmal (not in long bursts)
 - No vomiting after cough
 - No apnoea
- Pink, reactive
- Vital signs
 - Temp 37°C,
 - Heart rate 180 per minute ↑
 - Breathing rate 38
- Mild chest wall indrawing = sucking in of skin between ribs

Investigations

- Full blood count

- Haemoglobin 118

Normal

- White cell count 49 ↑ ↑ (5-15)

Way

Way

- Chest xray

- Showed pneumonia

Way

to high!

Impression: whooping cough

- Nasogastric feeds
- Antibiotics
- Progress
 - Heart rate 180 to 200 (really fast)
 - Increased breathing effort
 - Day 3 stopped breathing
 - Resuscitation with return of heart rate & breathing
 - Transfer to Paediatric Intensive Care Unit

Progress in PICU

- Put on a breathing machine
- IV fluids and cardiac drugs
- Blood pressure very low
- No urine output
- Acidosis
- Death 2 days after transfer to PICU
- Nasopharyngeal sample grew *Bordetella pertussis*:
the whooping cough bug

Doctors warn parents to keep newborns at home as whooping cough epidemic escalates

By Jane Hansen | [The Sunday Telegraph](#) | May 15, 2011 12:00am | 46 comments

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David and Toni McCaffery with baby Sarah who lost their daughter Dana to whooping cough. Picture: Brian Pamphilon.

- Whooping cough epidemic hits NSW

Gone



Dana Elizabeth McCaffery

5th February 2009 - 9th March 2009

Upon completion of this presentation, and even allowing for the odd senior or junior moment, you should be able to:

- Identify that pertussis remains a big problem globally
- List the main reasons New Zealand has a bigger pertussis problem than Australia, the UK and the USA
- Recognise why pertussis remains a diagnostic challenge
- State why our immunisation policy should remain focussed on prevention of severe disease in infants

A senior moment

An instance of momentary forgetfulness or confusion that is attributed to the aging process

A junior moment



A senior having a “junior” moment



A junior having a “senior” moment



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Immunisation programmes have decreased the incidence of pertussis

1980:

- almost 2 million reported cases
- low (~20%) vaccination coverage



2010:

- ~91,000 reported cases
- High (~80%) vaccination coverage

Global pertussis disease burden 2003

- 300,000 deaths per year
- 50 million cases in children worldwide each year
- Disability-adjusted life years in 2000

Disability adjusted life years = years of life lost + years lived with disability

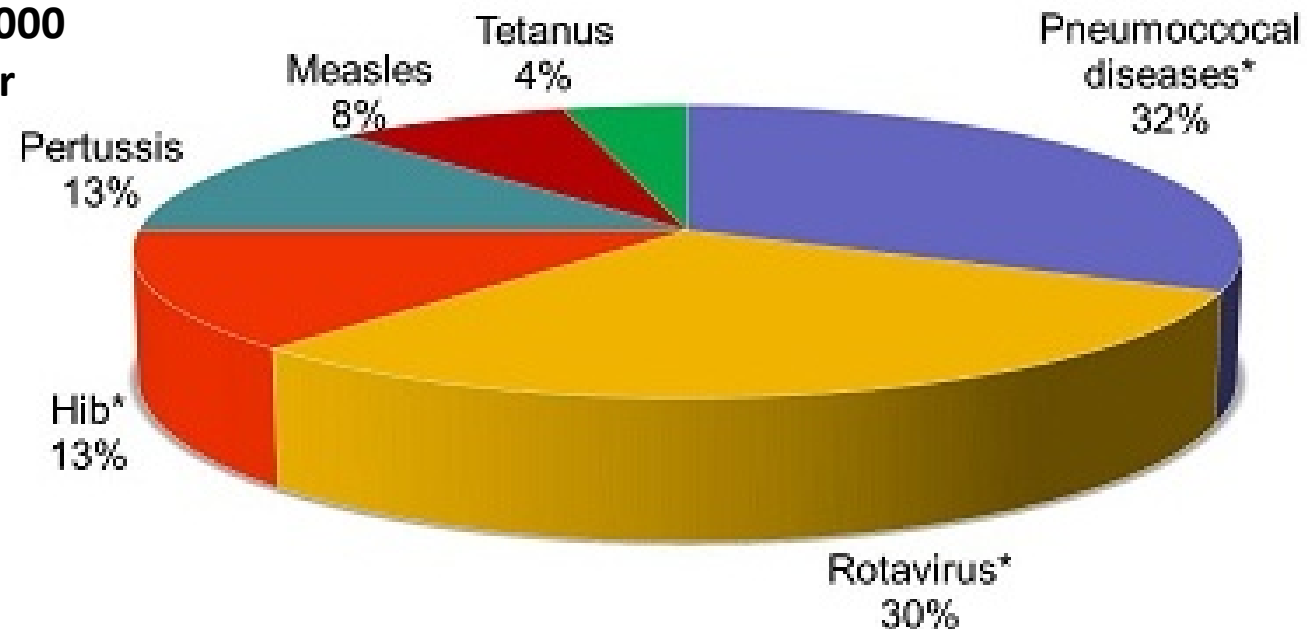
- Pertussis 12.7 million
- Lung cancer 11.4 million
- Meningitis 5.8 million

Crowcroft NS et al. How best to estimate the global burden of pertussis?
Lancet Infectious Diseases 2003;3:413-8.

Pertussis still causes significant global mortality...

Deaths in children younger than 5 years from vaccine-preventable diseases

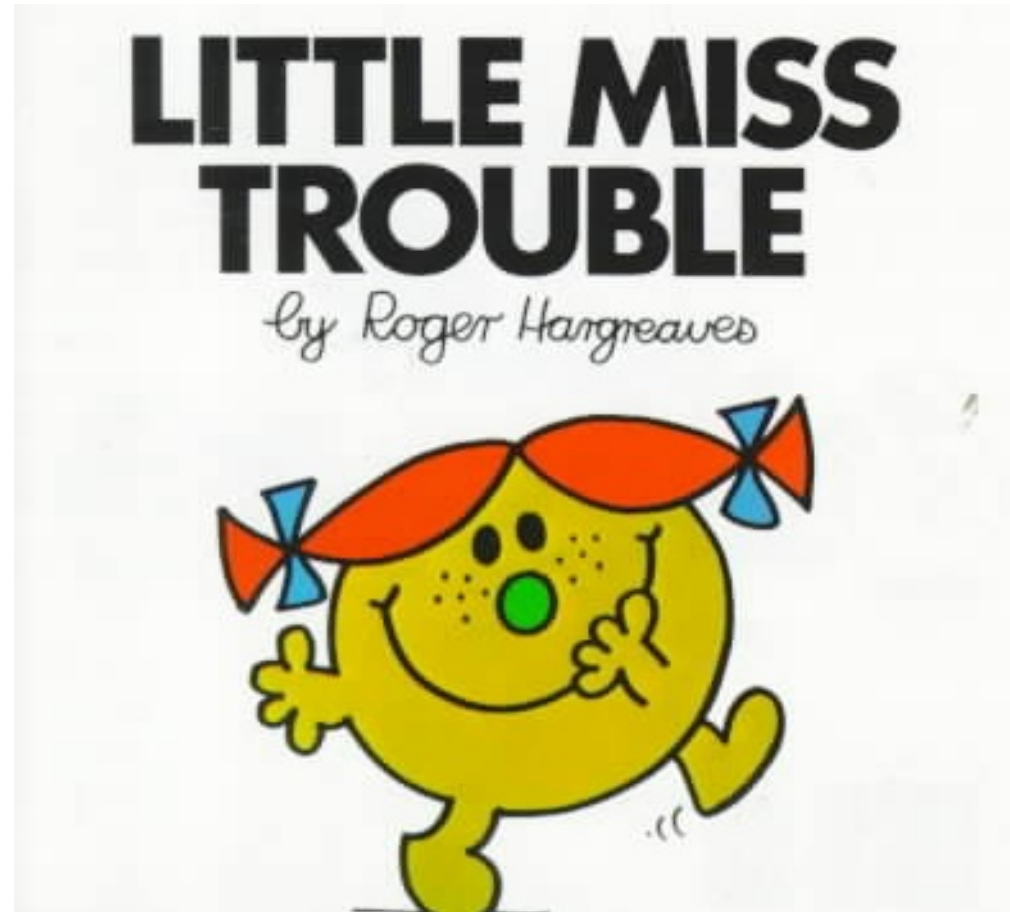
Pertussis: 195,000 deaths per year



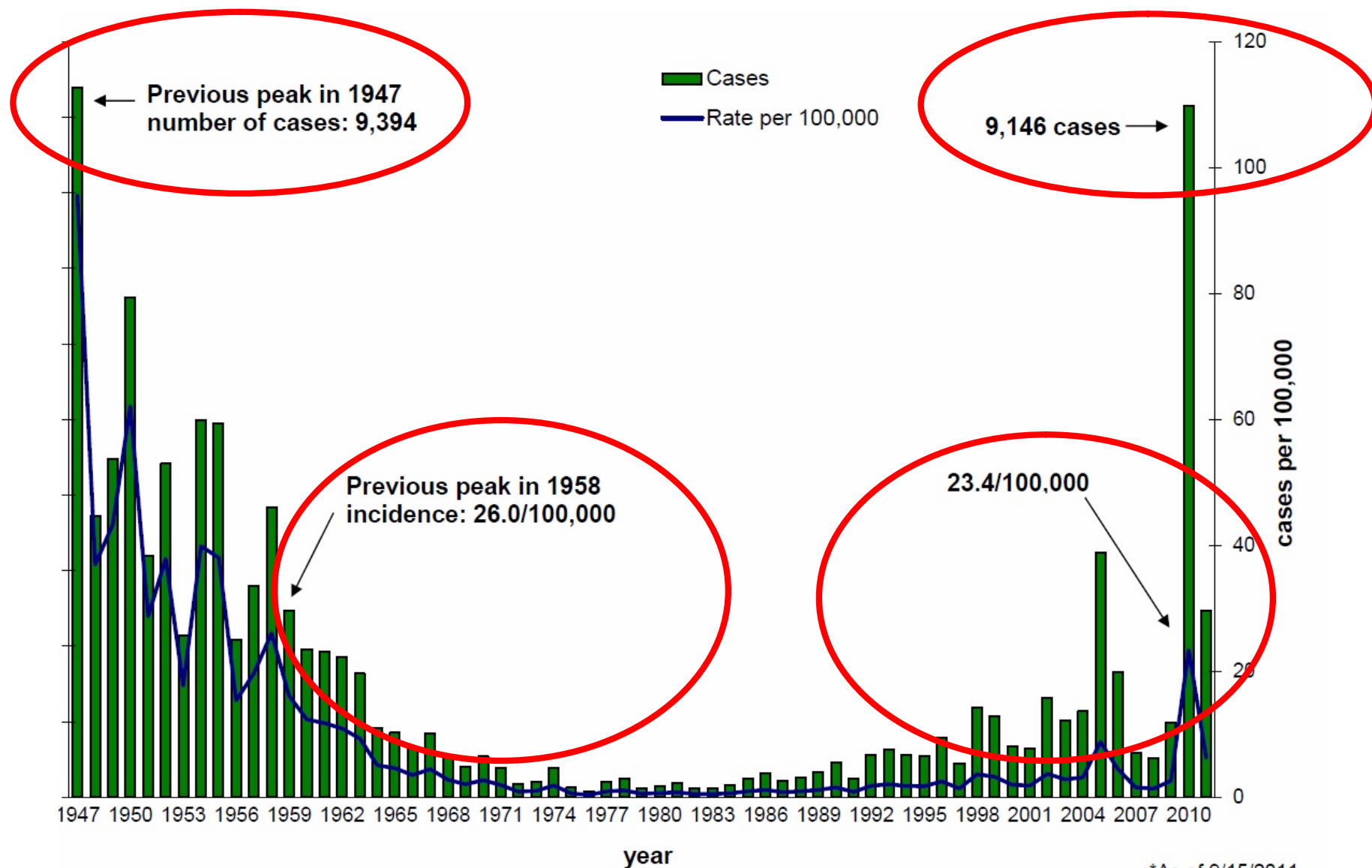
WHO. Vaccine preventable diseases. 2010. http://www.who.int/immunization_monitoring/diseases/en/

Black RE et al. Global, regional and national causes of child mortality in 2008: a systematic analysis. Lancet 2010;375:1969-97.

Recent trouble with pertussis



California: pertussis from 1947–2011*



*As of 9/15/2011

Recent trouble with pertussis

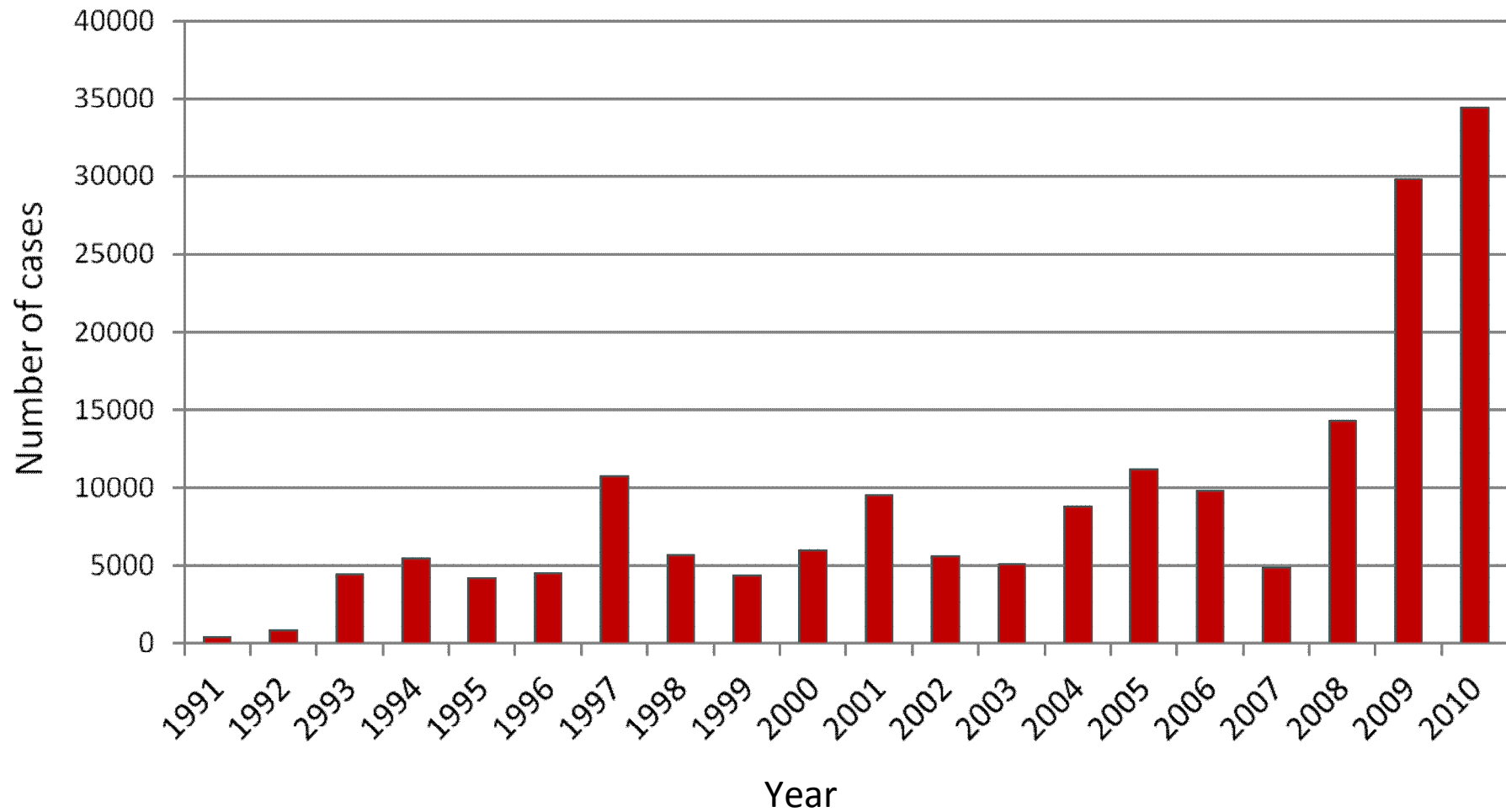
- California 2010



- 9,000 cases, 10 infant deaths

California Department of Public Health. CDPH says no whooping cough deaths in California during 2011. Available at <http://www.cdph.ca.gov/Pages/NR12-005.aspx>

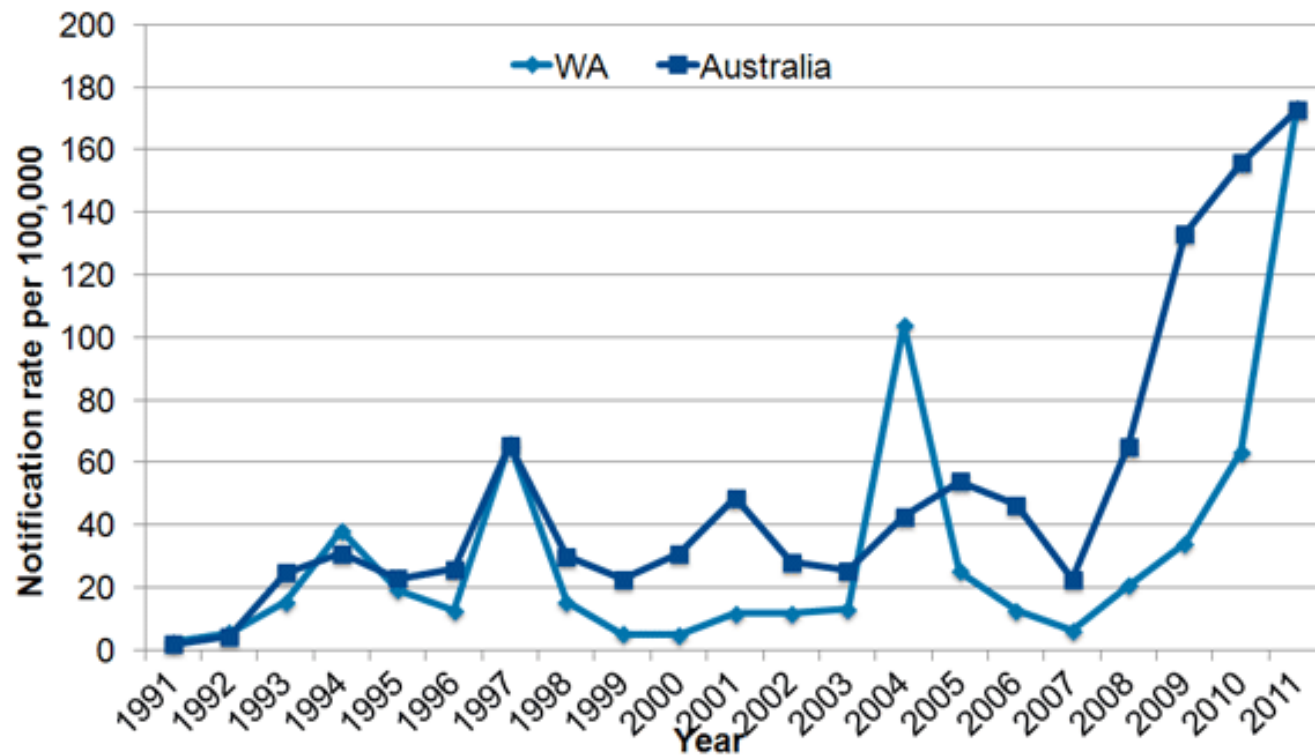
Australia: annual pertussis notifications 1991-2010



Australia's National Notifiable Diseases Surveillance System.

<http://www.health.gov.au/cde/Source/Data/5.pdf>

Pertussis epidemic in Australia since 2007

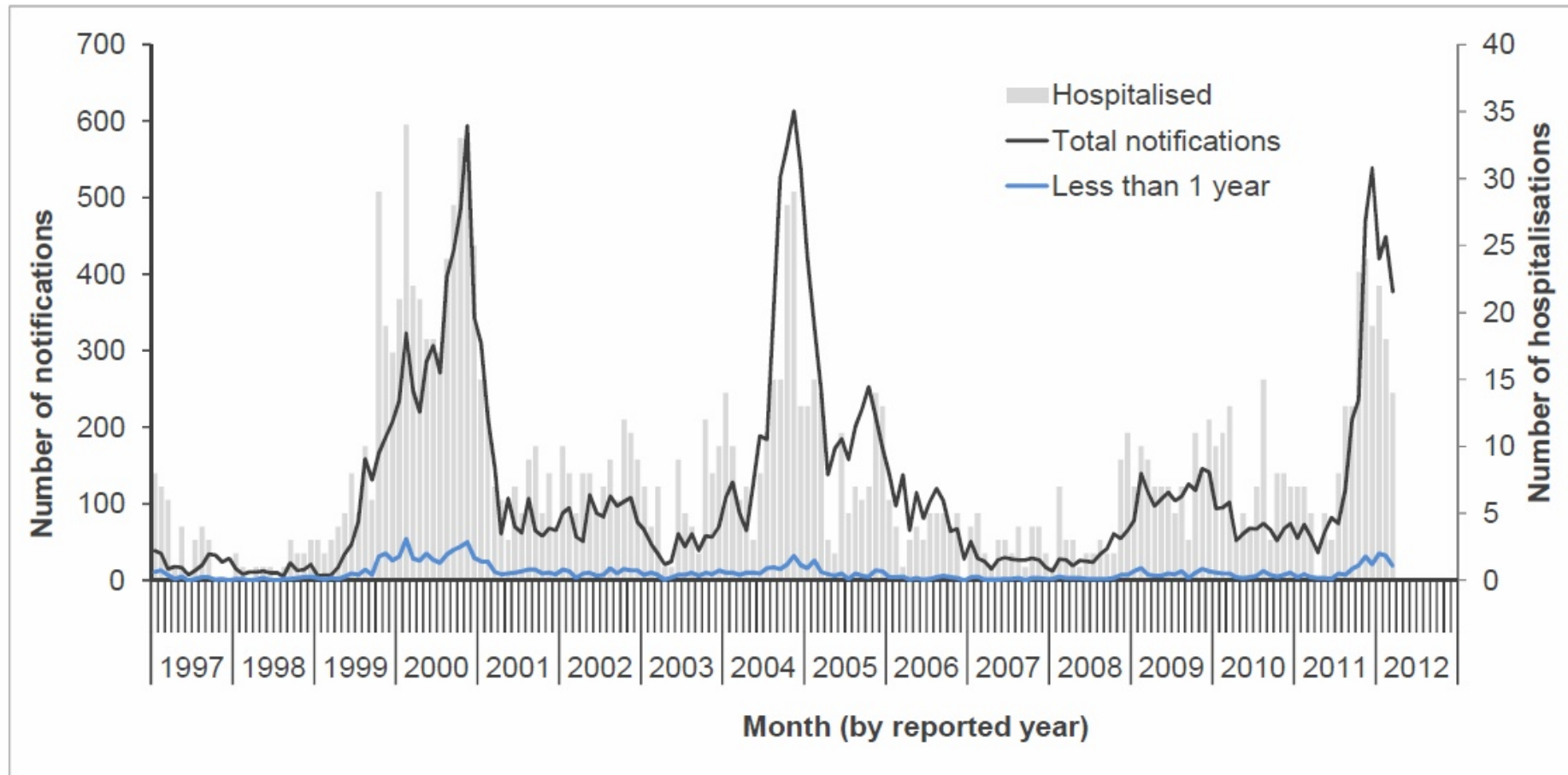


Dana Elizabeth McCaffery
5th February 2009 - 9th March 2009

Western Australia (WA): One death from pertussis in each of 2008, 2009, 2010 and

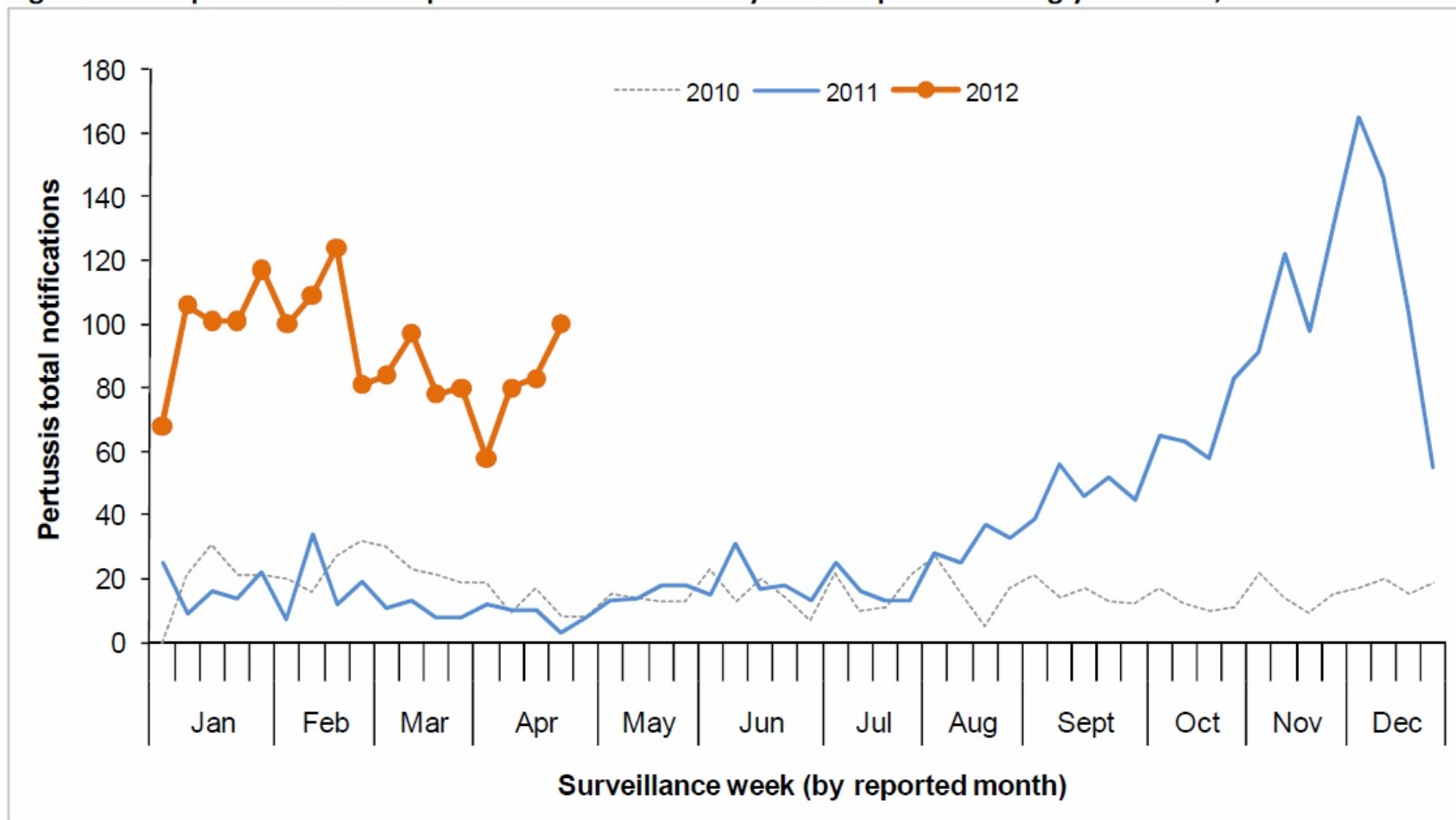
Current epidemic in New Zealand

NZ pertussis notifications & hospitalisations 1997 to March 2012



New Zealand: notifications are rising

Figure 1: Comparative trend of pertussis notifications by week reported during years 2010, 2011 and 2012



Upon completion of this
presentation you should be able to:

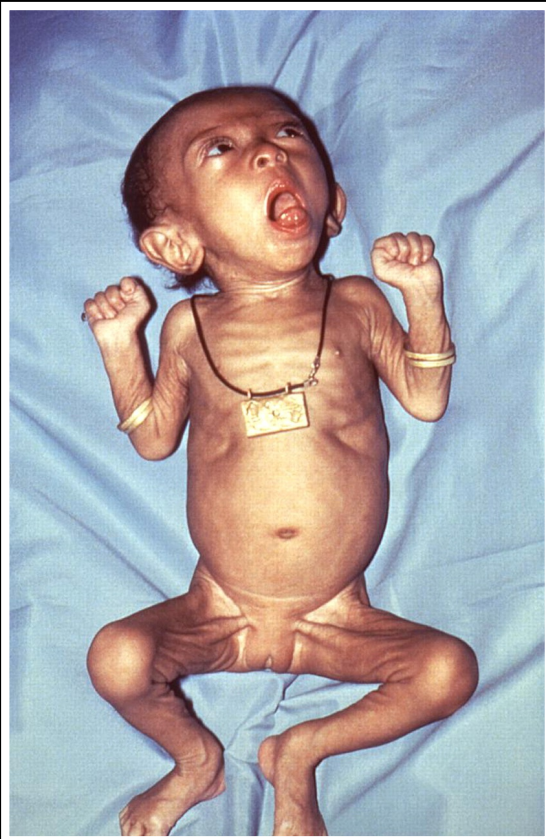
Identify that pertussis remains a big
problem globally

Identify that pertussis remains a big problem globally



- Pertussis is ranked among the 10 leading causes of child death
- It is a bigger cause of disability than lung cancer or meningitis
- It kills young babies even if they are in the best intensive care units in the world and despite every piece of technology known to mankind
- There have been recent large epidemics in the USA and Australia with a number of fatalities
- There is an epidemic currently in New Zealand

Pertussis remains a big problem globally

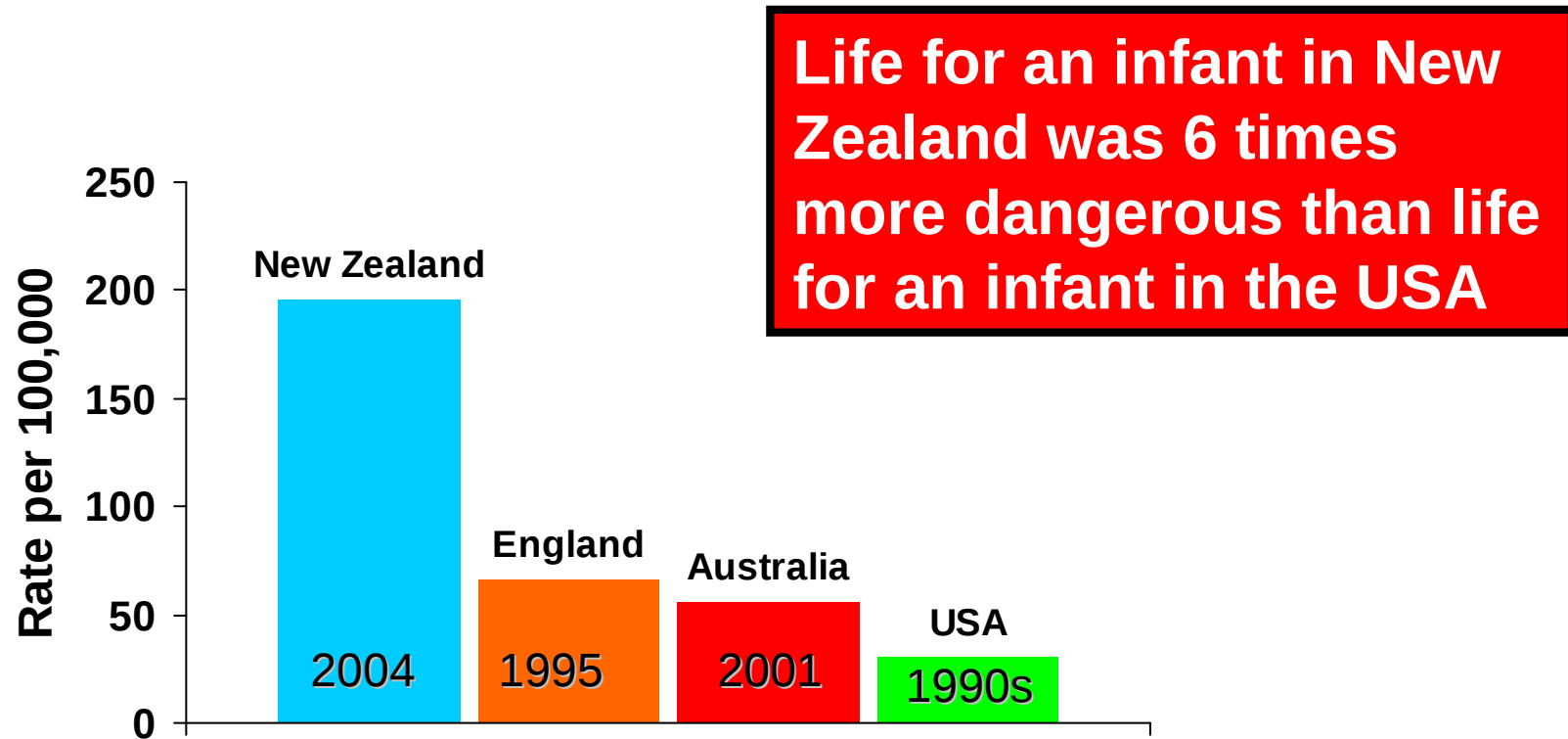


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International comparison pertussis hospitalisation rates



Somerville et al. J Paed Child Health 2007;43:617-622

Elliot E. PIDJ 2004;23:246-52.

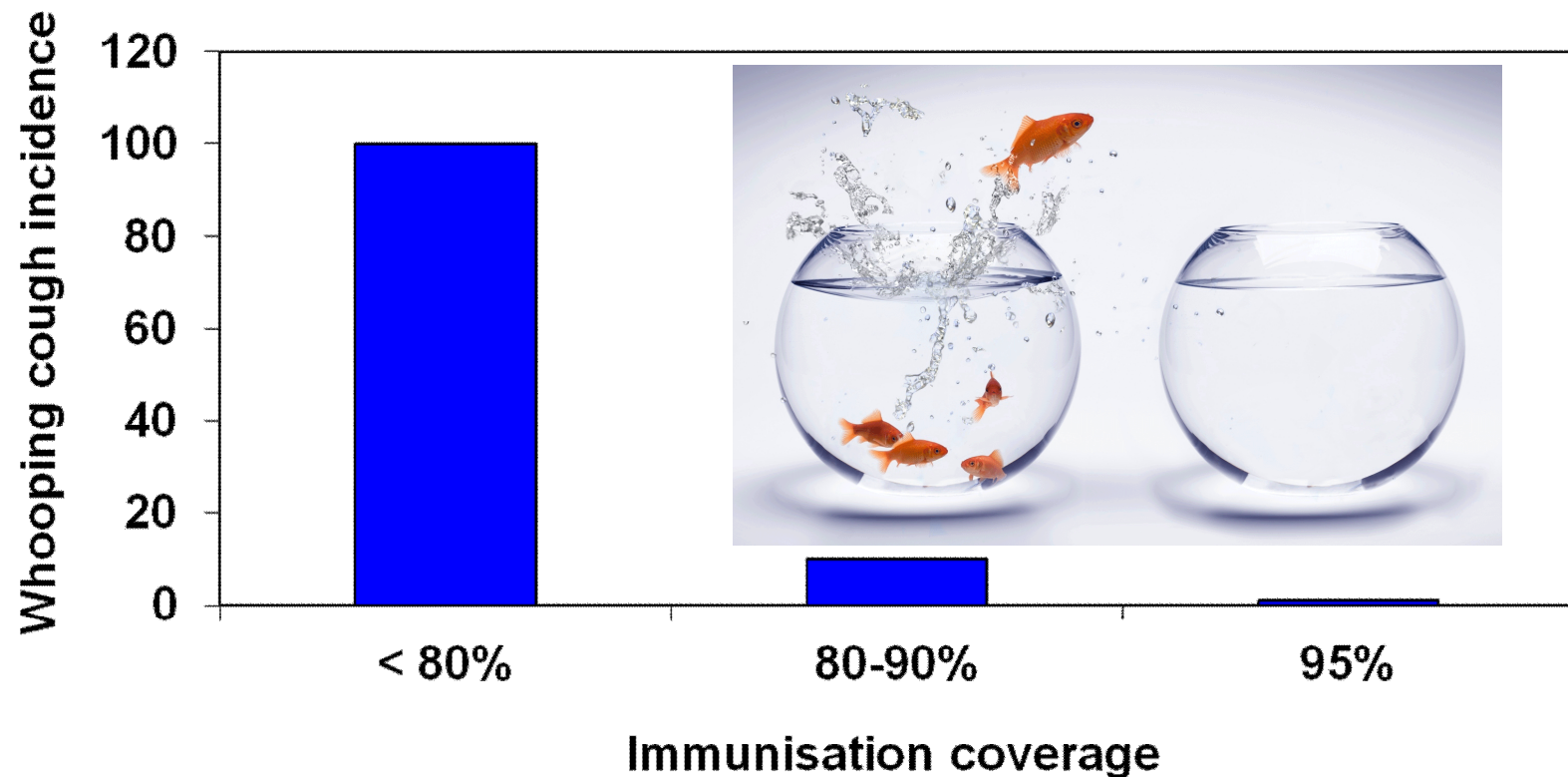
Van Buynder P. Epidemiol Infect 1999;123:403-11

Tanaka M. JAMA 2003;290:2968-75.

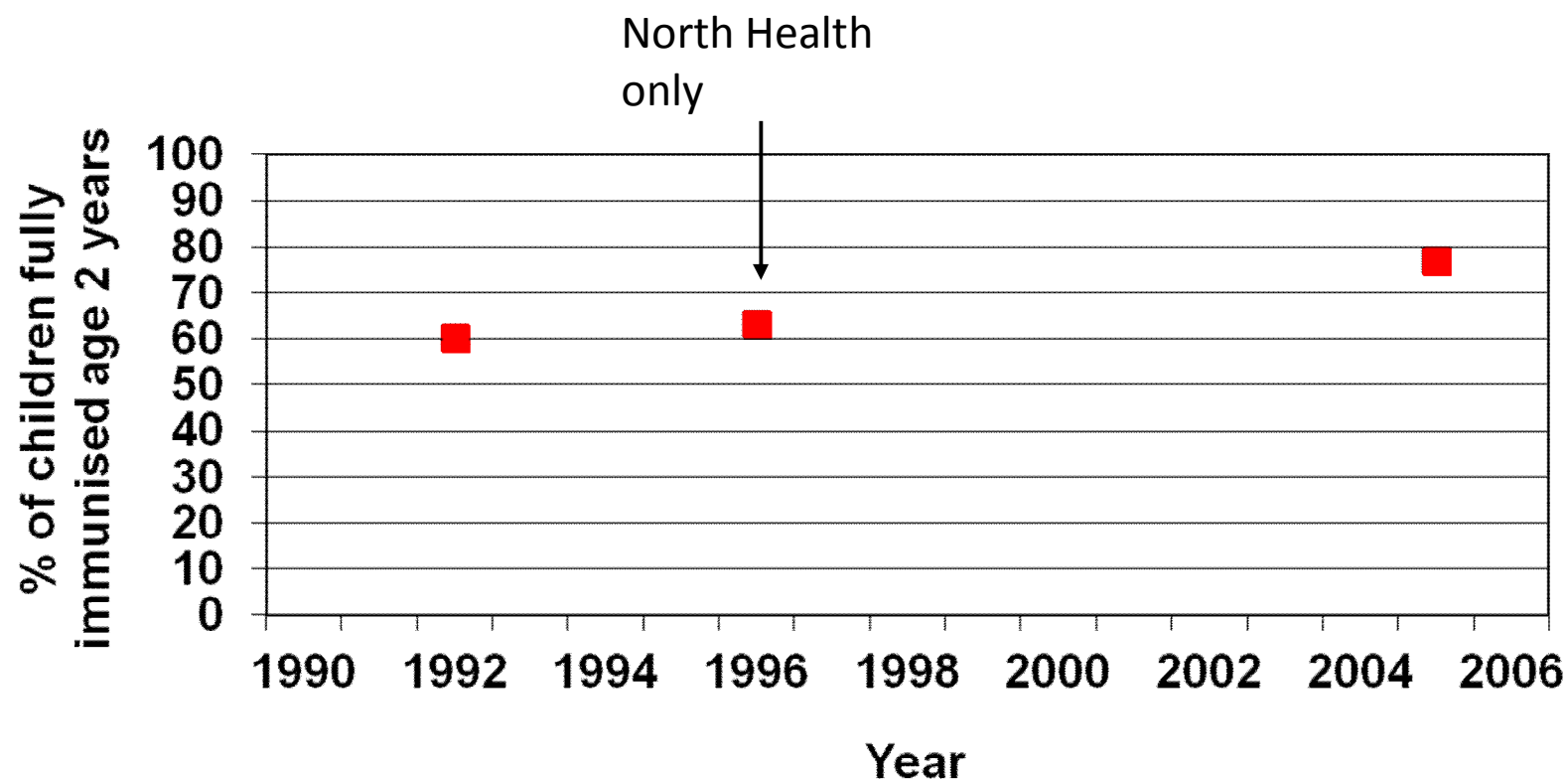
Nine reasons why pertussis has been a bigger problem in New Zealand

- Coverage
 - Coverage
 - Coverage
 - Coverage
 - Coverage
 - Coverage
 - Coverage
 - Coverage

To control pertussis you have to do immunisation well



Trends over time in immunisation coverage in New Zealand



Ministry of Health. The National Childhood Immunisation Coverage Survey 2005
Lennon D et al. Immunisation coverage in North Health. 1996 immunisation coverage survey
Anonymous. Immunisation coverage in New Zealand 1992

Health TARGETS

2009/10

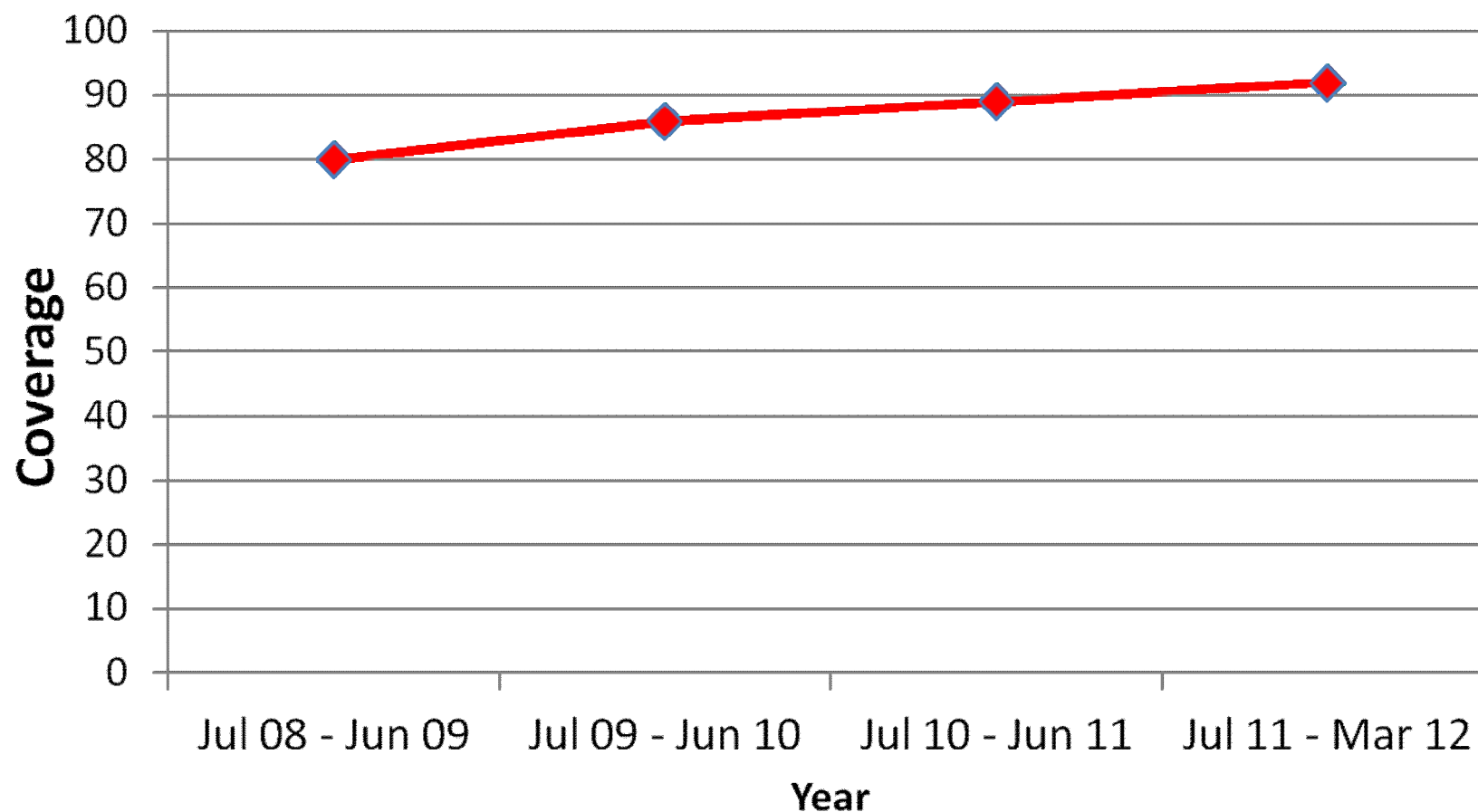
Increasing immunisation coverage has been one of New Zealand's national health targets since these were first introduced in 2007

Fully immunised @ age 2 years

- 85% by July 2010
- 90% by July 2011
- 95% by July 2012

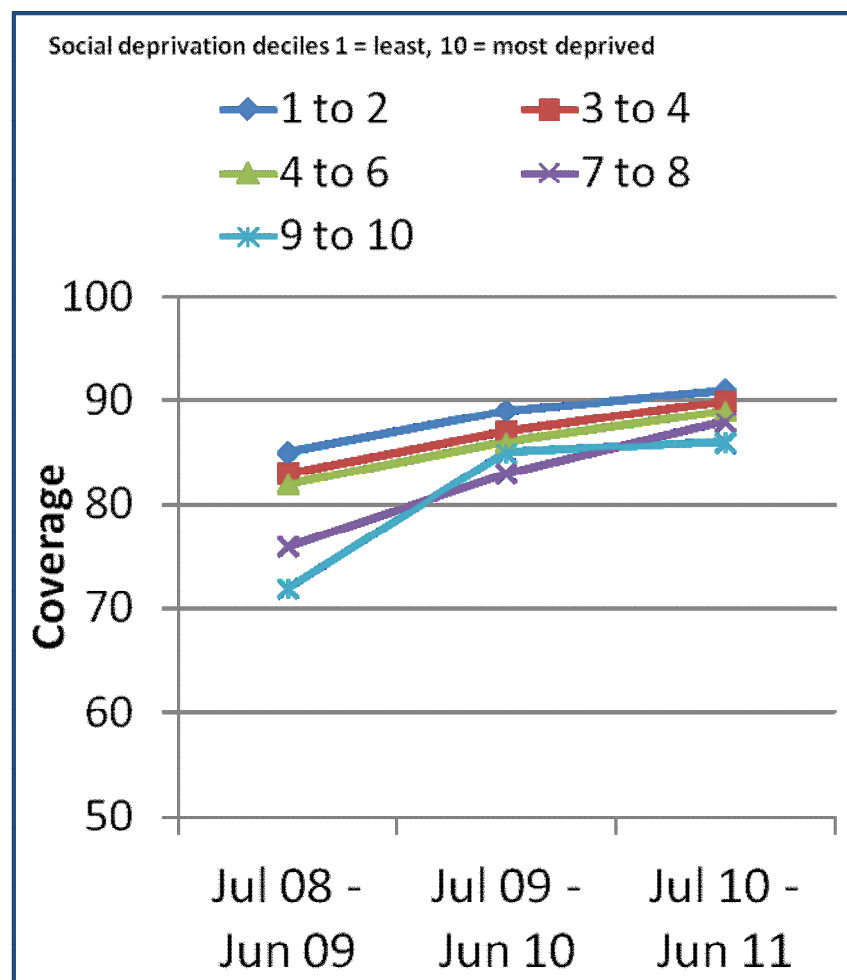
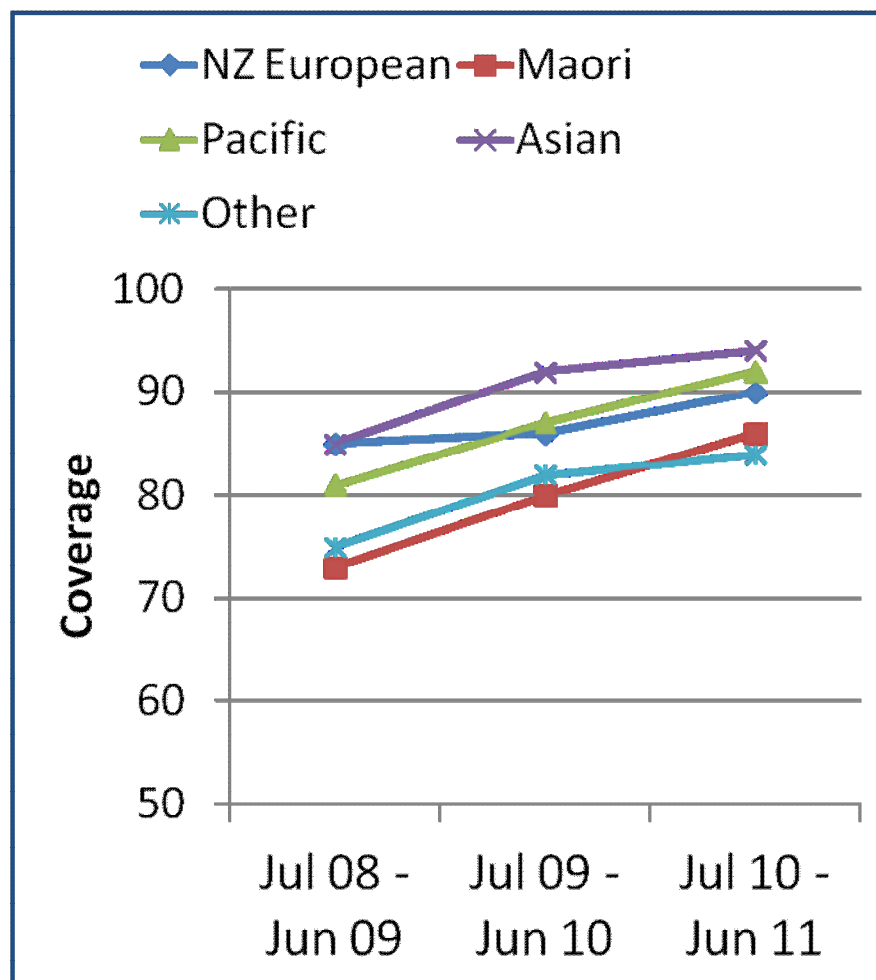
Coverage @ age 2 years for 3 months to end March 2012
92%!

National coverage at age 24 months 2008 to March 2012



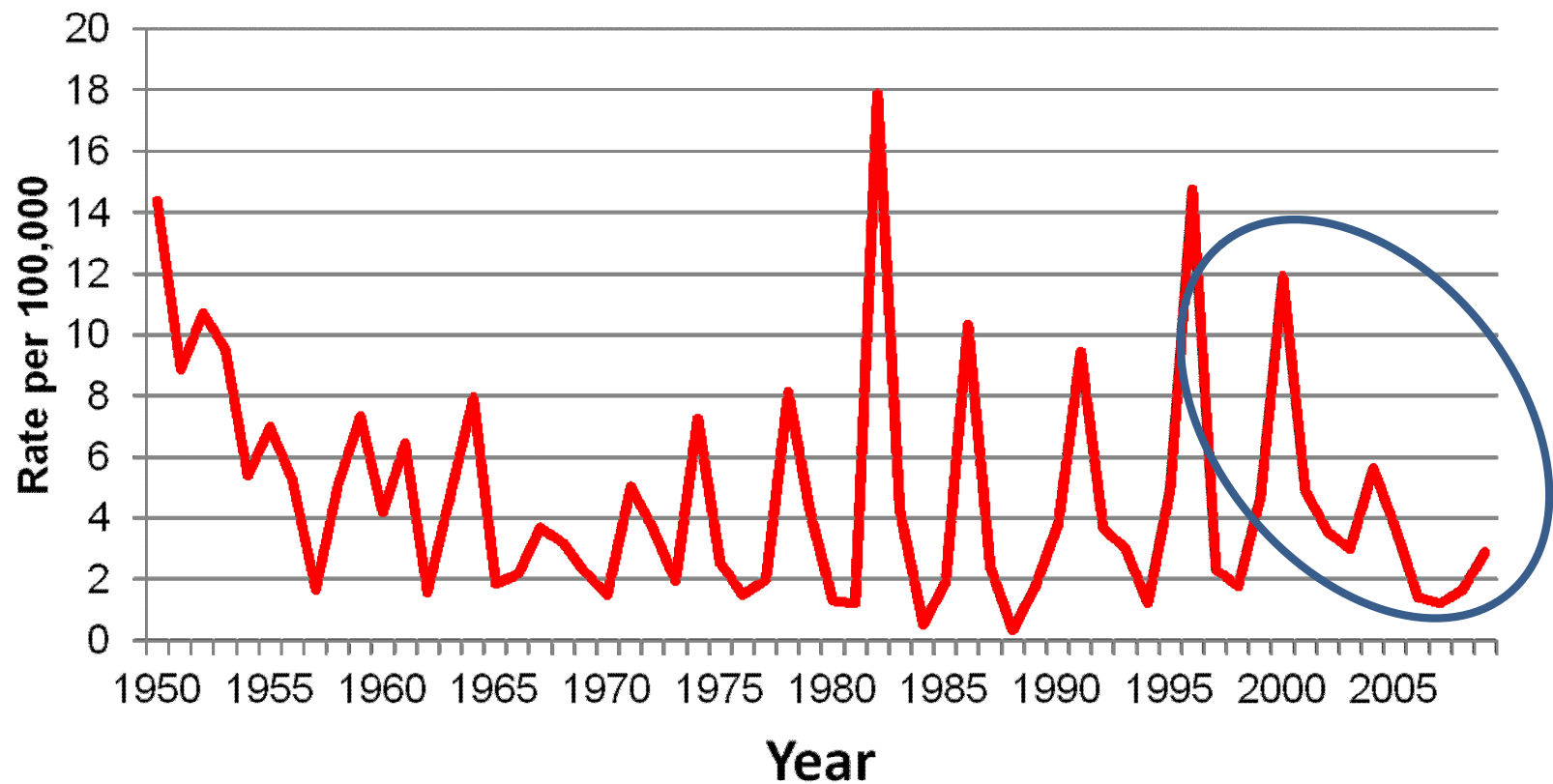
<http://www.health.govt.nz/our-work/preventative-health-wellness/immunisation/immunisation-coverage/national-and-dhb-immunisation-data>

National coverage at age 24 months 2008 to 2011 by ethnicity and social deprivation



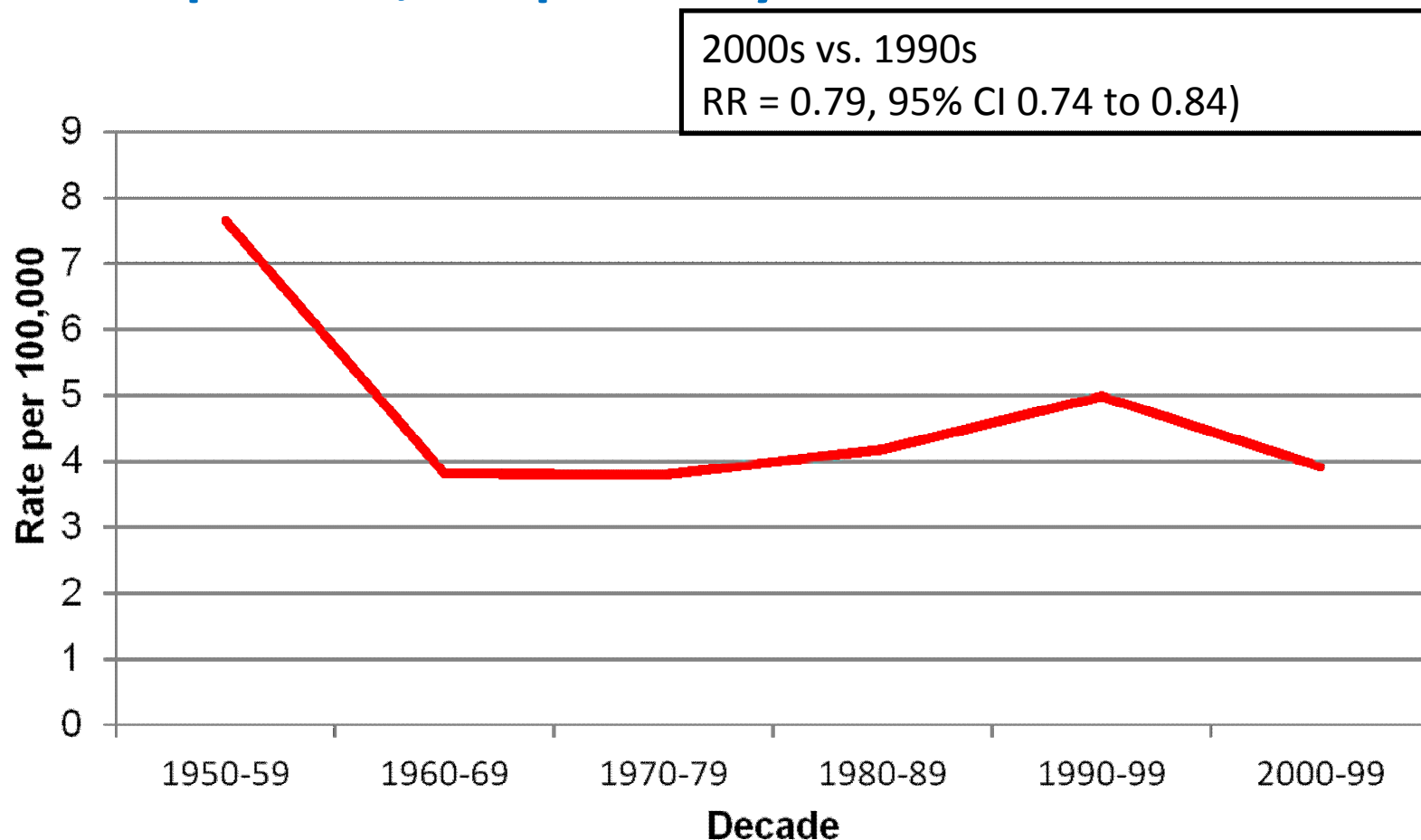
<http://www.health.govt.nz/our-work/preventative-health-wellness/immunisation/immunisation-coverage/national-and-dhb-immunisation-data>

Annual pertussis hospital discharge in New Zealand per 100,000 population 1950 to 2009



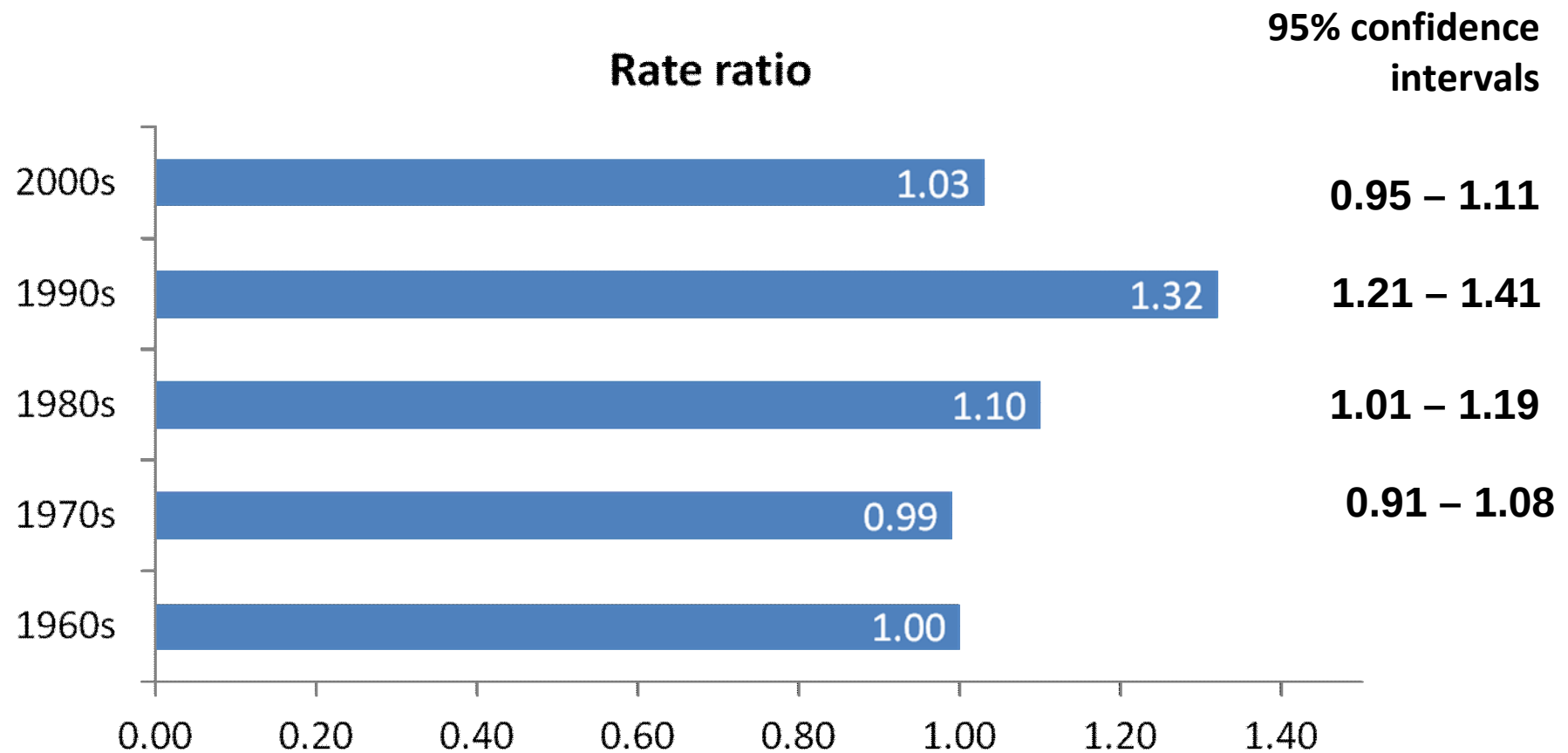
Somerville R et al. Hospitalisations due to pertussis in New Zealand in the preimmunisation and mass immunisation eras. *J Paediatr Child Health* 2007; 43: 147-153.

Annual average pertussis hospital discharge rate per decade per 100,000 person-years 1950 to 2009



The 2000s was the first decade since the 1960s during which there was a decrease in pertussis hospital discharge rates in New Zealand

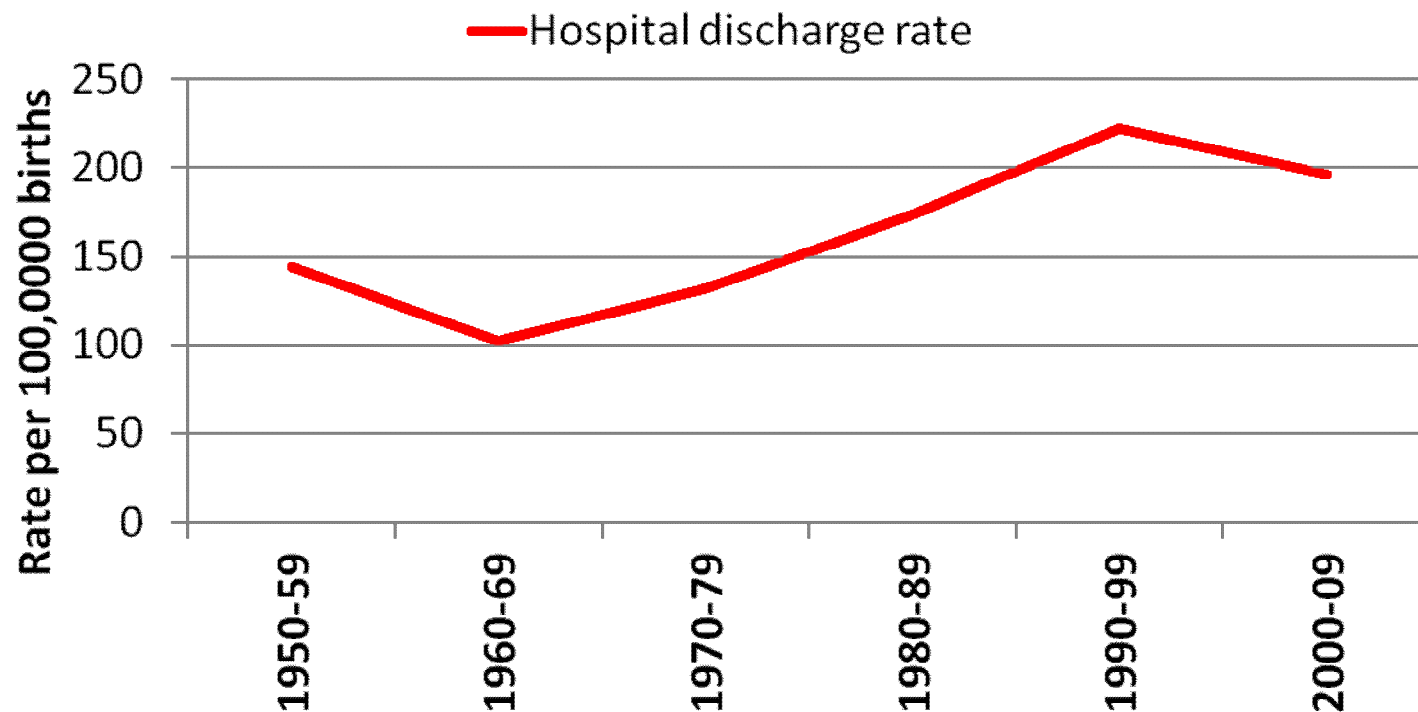
Pertussis hospital admission rates all ages per decade versus 1960s



Average annual infant pertussis hospital discharge rate per decade per 100 000 person-births 1951 to 2009

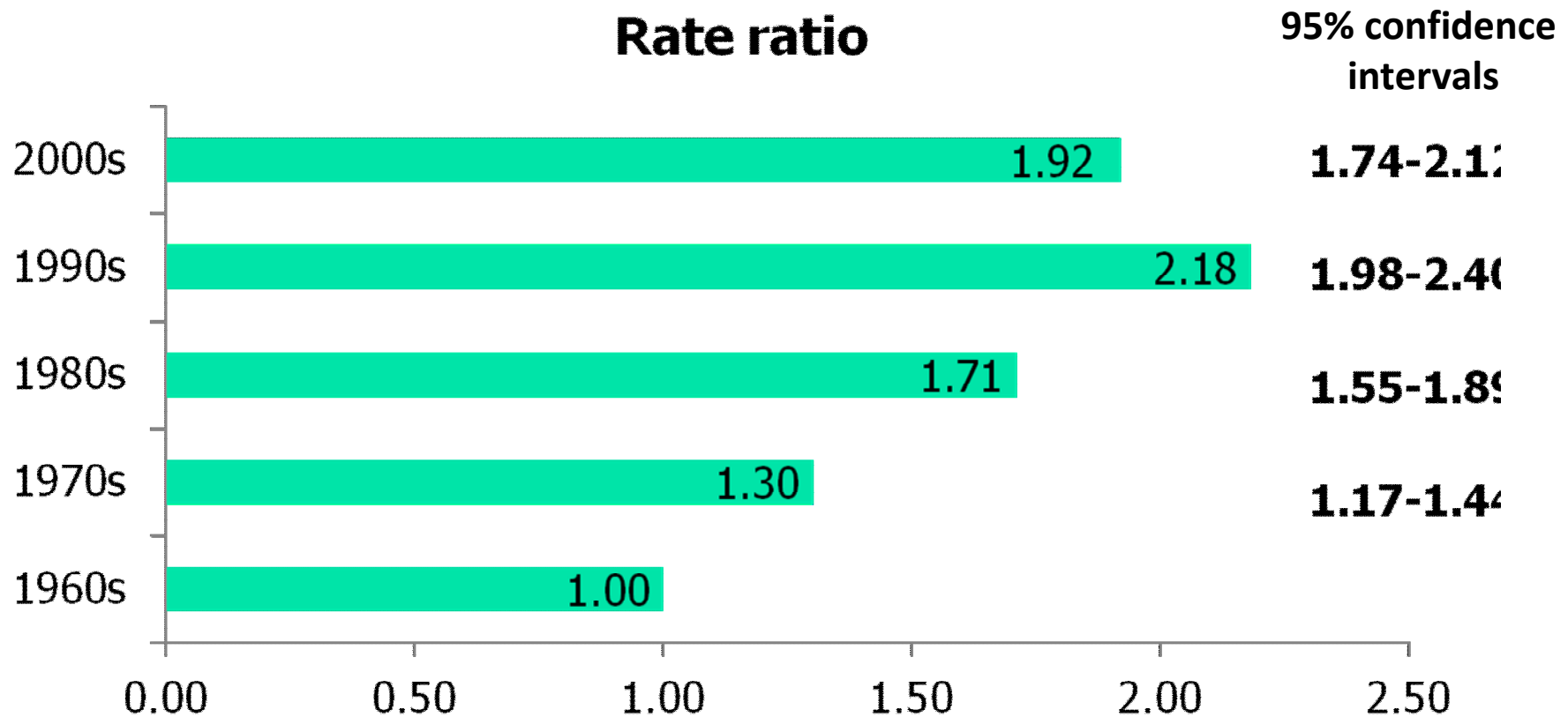
2000s vs. 1990s

RR = 0.88, 95% CI 0.81 to 0.96



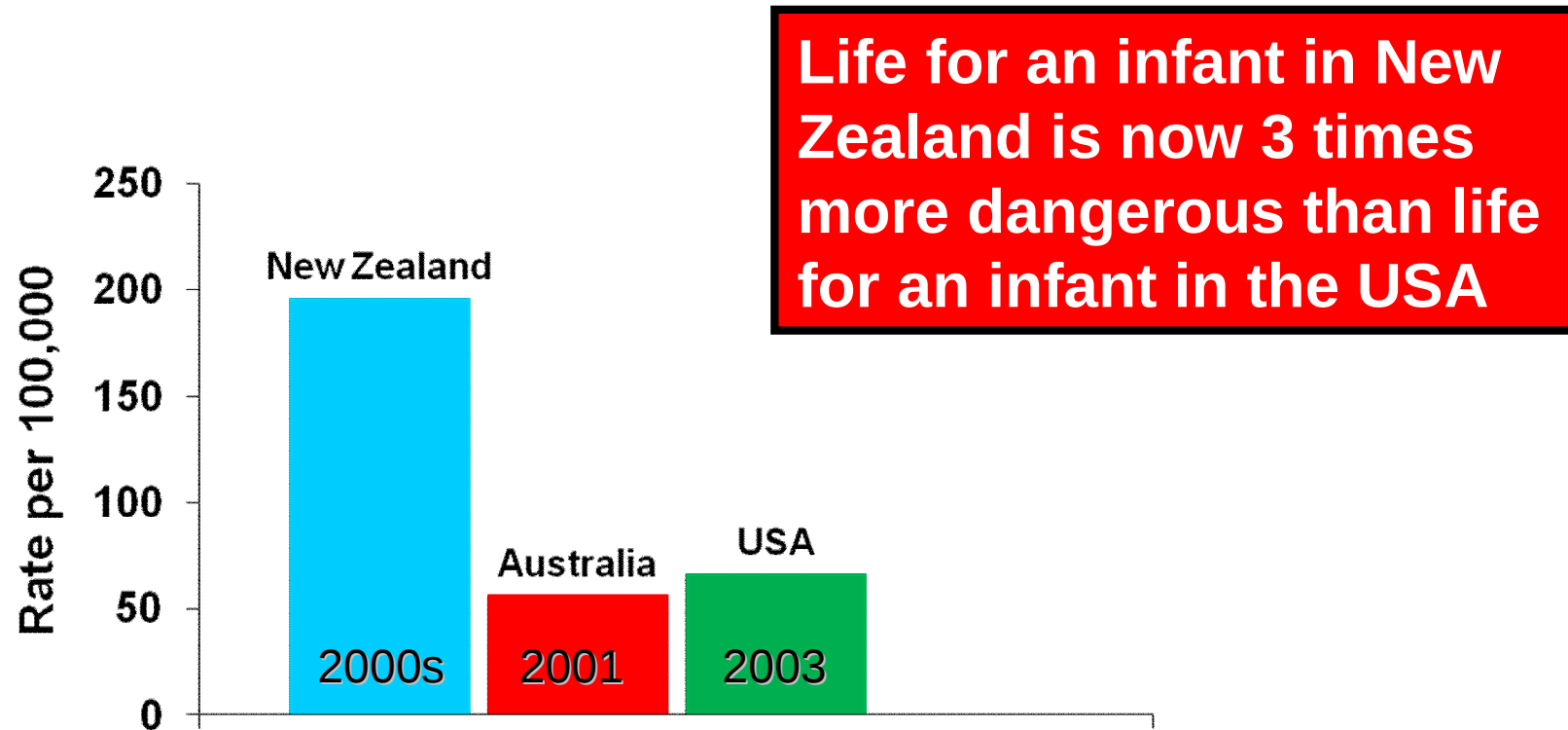
The 2000s was the first decade since the 1960s during which there was a decrease in the infant pertussis hospital discharge rate in New Zealand

Pertussis hospitalisation rates infants per decade versus 1960s



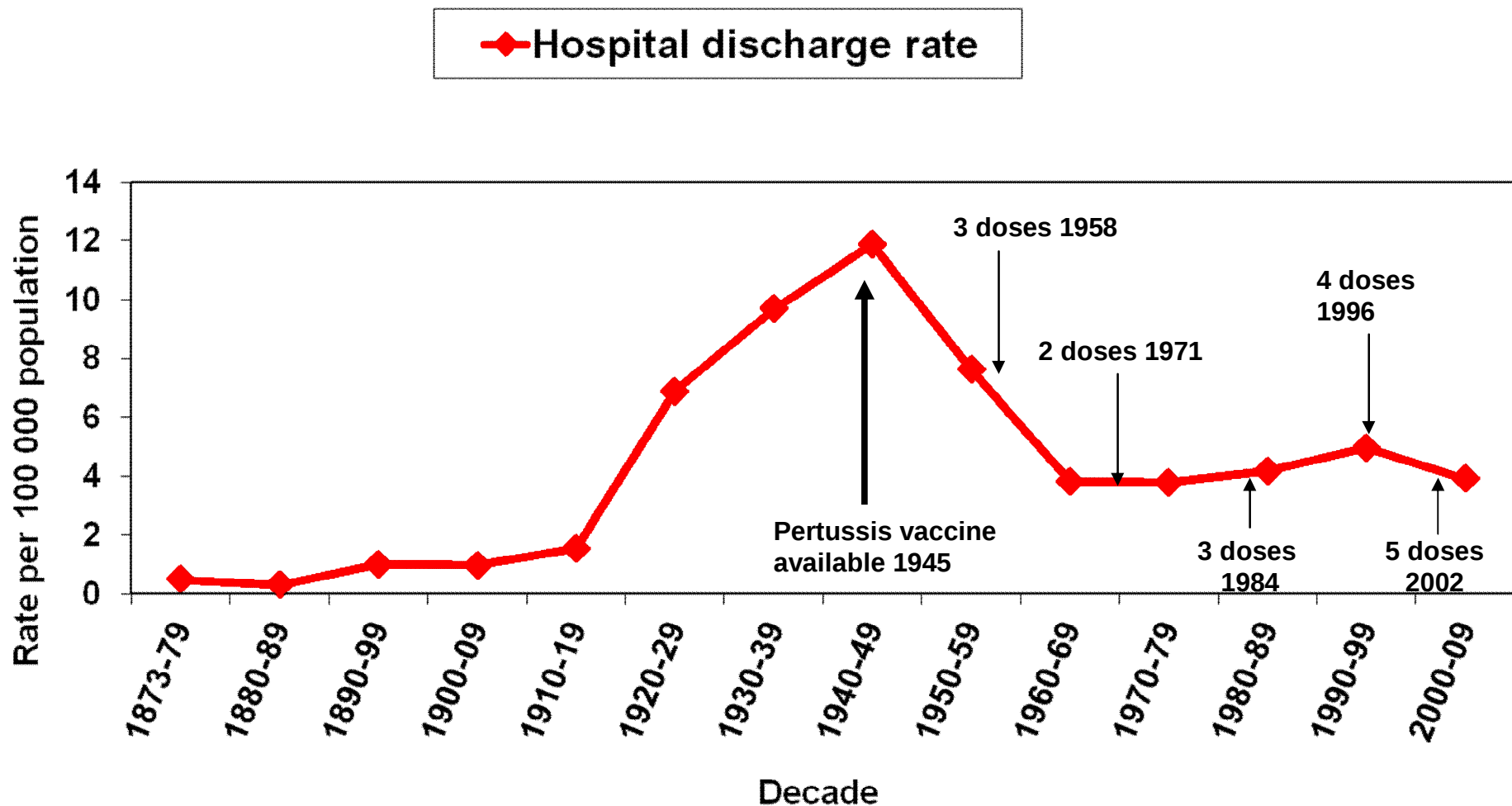
Infant pertussis hospitalisation rate in each decade since the 1960s is greater than it was in the 1960s

International comparison pertussis hospitalisation rates



Grant CC. *Australian and New Zealand Journal of Public Health* 2012;In press.
Elliott E, et al. *Pediatric Infectious Disease Journal* 2004;23(3):246-52.
Cortese MM, et al. *Pediatrics* 2008;121(3):484-92

Annual pertussis hospital discharge rate per decade per 100,000 person years 1873 to 2009

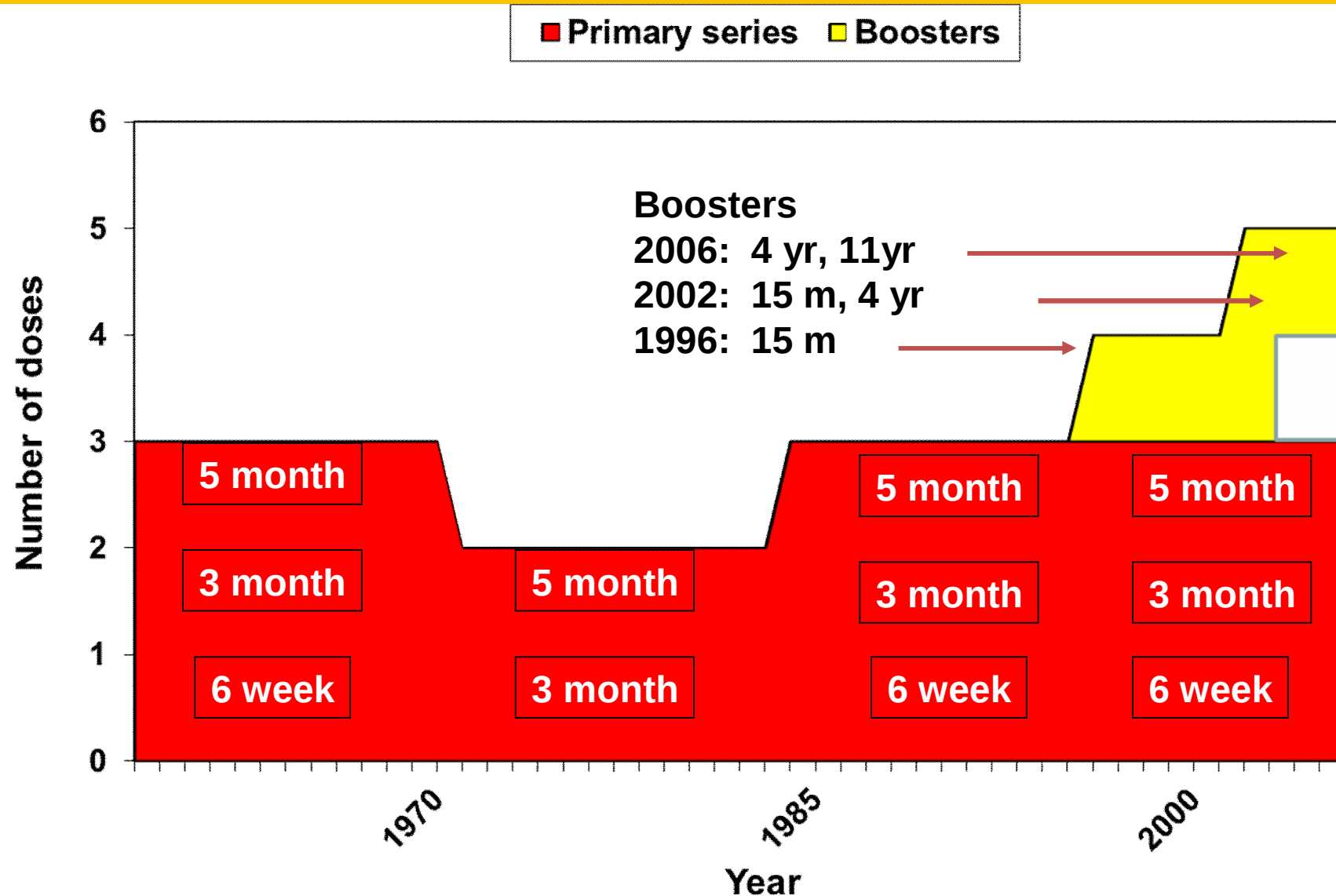


Somerville RL, Grant CC, et al. *J Paed Child Health* 2007;43:147-53.

Grant CC. *Aust NZ J Public Health* 2012 in press

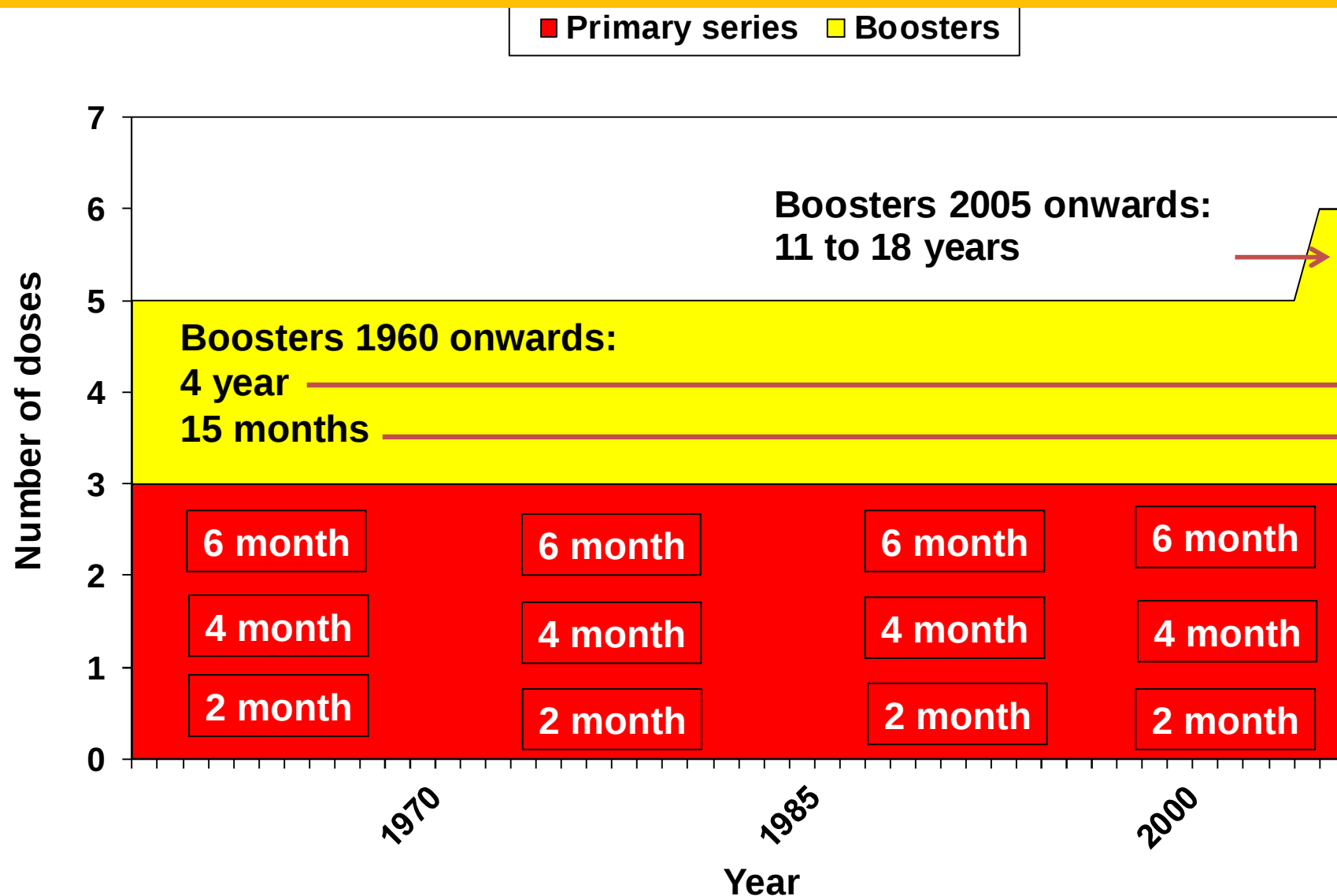
Pertussis Vaccination Schedule in New Zealand

Average annual infant pertussis hospitalisation rate in the 2000s = 196 per 100,000



Pertussis Vaccination Schedule in USA

Annual infant pertussis hospitalisation rate 2000 (66 per 100,000), 2003 (65 per 100,000).



Upon completion of this
presentation you should be able to:

List the main reasons New Zealand has
a bigger pertussis problem than
Australia, the UK and the USA

List the main reasons New Zealand has a bigger pertussis problem than Australia, the UK and the USA



- Low coverage of the primary immunisation series at least since the 1990s
- Late introduction of booster doses
- Scheduling changes that have been driven by concerns about vaccine safety more than greater disease control

Upon completion of this presentation you should be able to:



- Identify that pertussis remains a big problem globally
- List the main reasons New Zealand has a bigger pertussis problem than Australia, the UK and the USA
- Recognise why pertussis remains a diagnostic challenge
- State why our immunisation policy should remain focussed on prevention of severe disease in infants

Recognise why pertussis remains a diagnostic challenge



© Stephanie Robin/Kelley Ryden





Dana Elizabeth McCaffery
5th February 2009 - 9th March 2009

Babies with pertussis

- Can become very sick quickly
- Can present with apnoea rather than cough
- Can look well in between episodes

Infant pertussis

Presenting History

4 weeks old

- 4 days loud breathing
- 2 days paroxysmal cough

Family history 1

3 year old sister

- Cough for 3 weeks
- Bronchiolitis
- Fully immunised

Past History

39/40 gestation

BW 3535 g

Healthy until now



Dana Elizabeth McCaffery

5th February 2009 - 9th March 2009

Family history 2

Mum + Dad prolonged cough

- During pregnancy

GP visit

Looked well
Viral illness

Paramedic visit

Middle of night 3
Better on arrival
Mums call

Emergency department

Paroxysmal cough 5 days

- Vomiting with cough 2 days
- Poor feeding 1 day

In the Emergency Department



- 5 apnoeic episodes with associated coughing
 - Desaturation to 50%
 - Heart Rate to 60/minute
- Oxygen
- Chest radiograph: pneumonia
- Admit to PICU

In Intensive Care Unit



- Day 2
 - Intubated & ventilated (with difficulty)
 - Multiple apnoeas
 - Thick secretions
- Day 8: Extubated (apnoeas)
- Day 12: To ward
- Day 17 norovirus diarrhoea



© Charles Prober, MD

Clinical presentation in young infants



Of those requiring PICU care

- Cough present for a median of 7 days
- Presenting symptoms/signs
 - Paroxysmal cough 75%
 - Apnoea 47%
- Only 31% meet clinical case definition at time of PICU admission

Surridge J, Segedin ER, Grant CC. Pertussis requiring intensive care. *Arch Dis Child* 2007;92:970-5.

School children with pertussis



Have vaccine modified disease

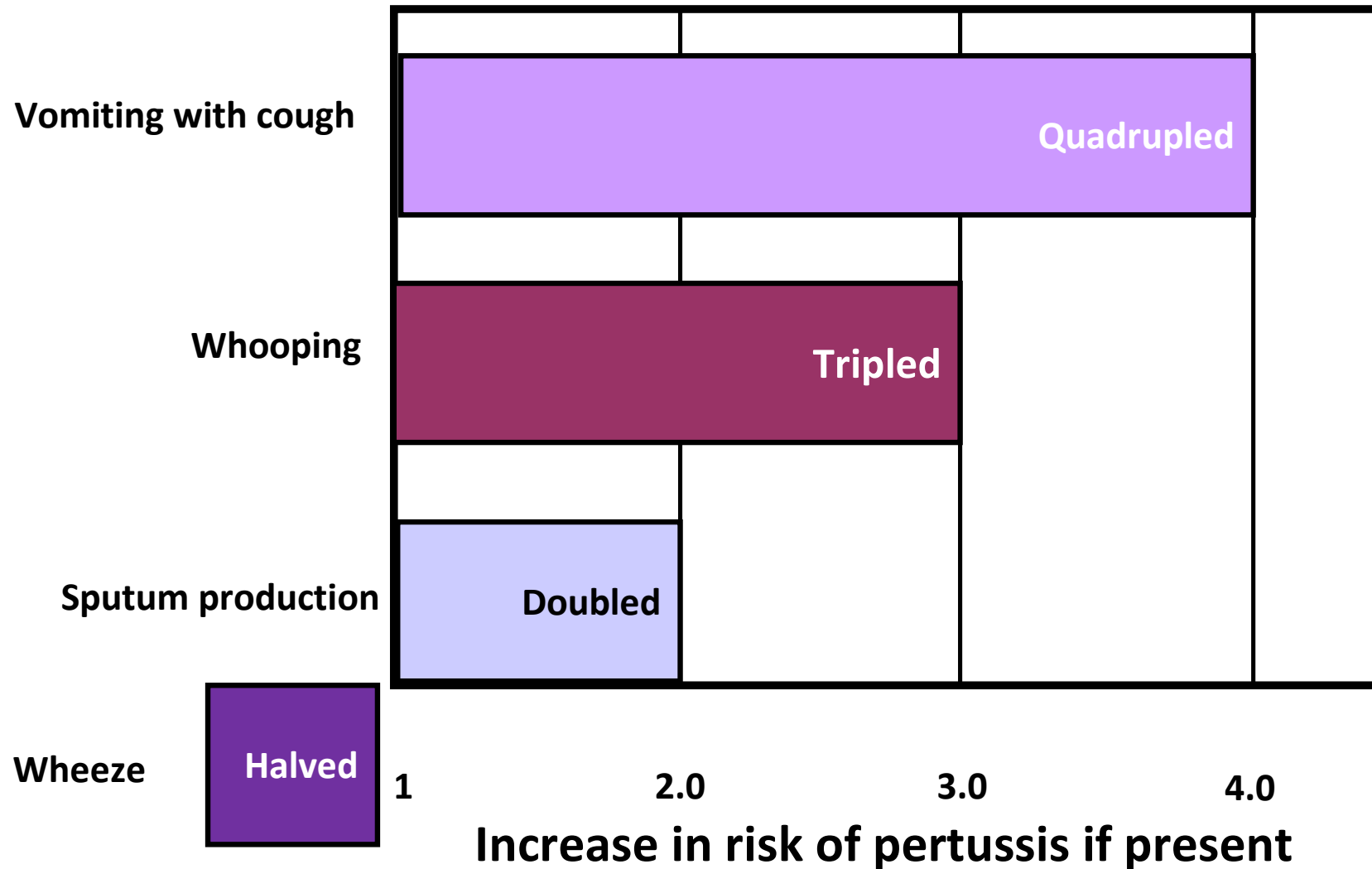
What does this do to their clinical presentation?

It makes it more subtle



Harder to differentiate from other causes of cough

Which school aged child with 2 weeks of cough has pertussis?



Apnoea

Sinus pain

Symptoms that don't differentiate
pertussis from other causes of
cough in school aged children

Cyanosis

Sweating

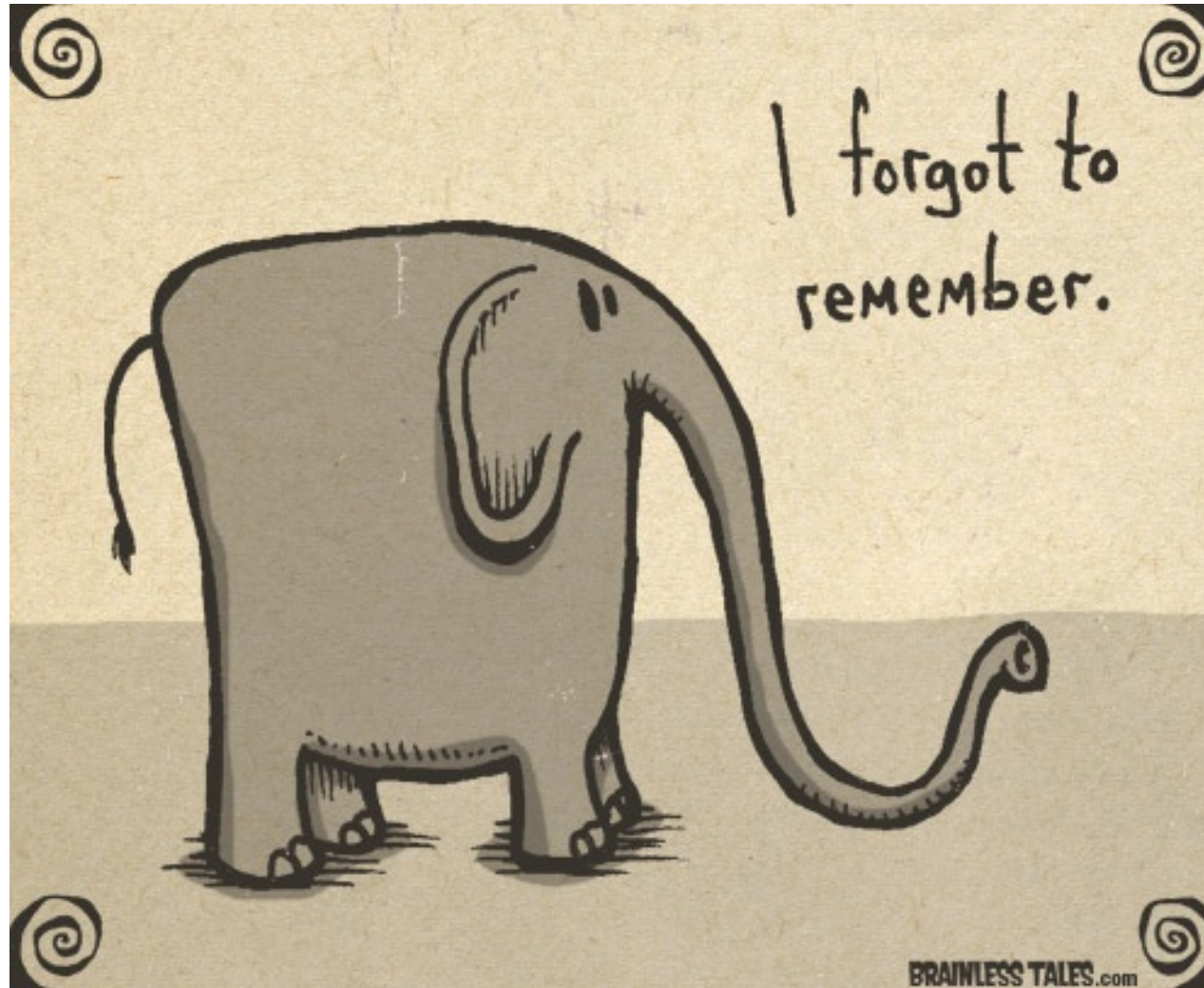
Sneezing

Adults with pertussis



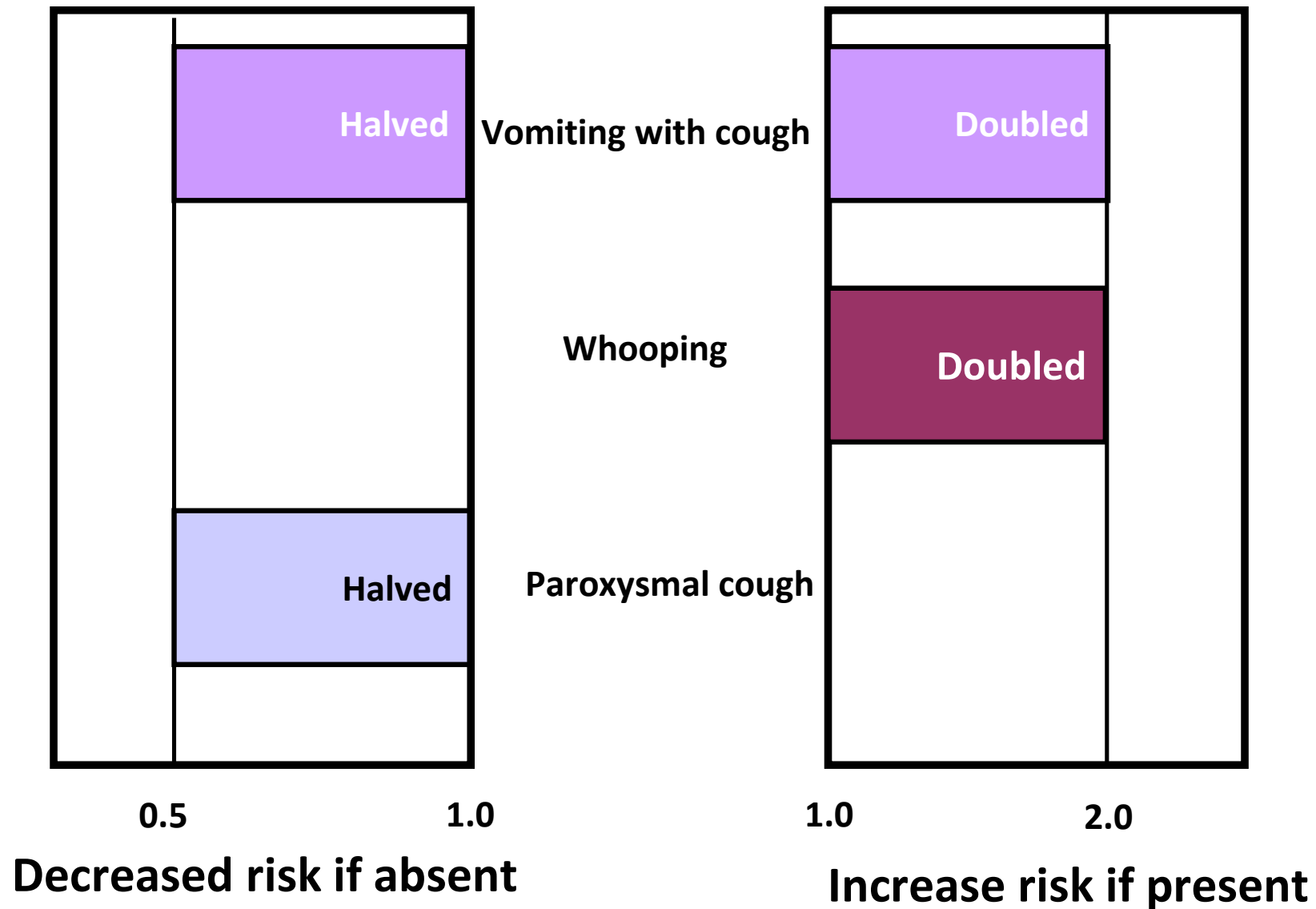
Have the symptoms

But people don't think of the disease



To think could this be pertussis

Which adolescent or adult with any cough has pertussis?



Upon completion of this
presentation you should be able to:

Recognise why pertussis remains a
diagnostic challenge

Recognise why pertussis remains a diagnostic challenge

- **Babies with pertussis**
 - Can become very sick quickly
 - Can present with apnoea rather than cough
 - Can look well in between episodes
- **School aged children with pertussis**
 - Have vaccine modified disease
 - In those with cough for 2 weeks
 - Vomiting with cough, whooping & sputum make pertussis more likely
 - Wheeze makes pertussis less likely
- **Adolescents and adults with pertussis**
 - Pertussis not considered
 - In adults with any cough
 - Vomiting with cough & whooping if present make pertussis more likely
 - If paroxysmal cough & vomiting are not present then pertussis less likely

Upon completion of this presentation you should be able to:

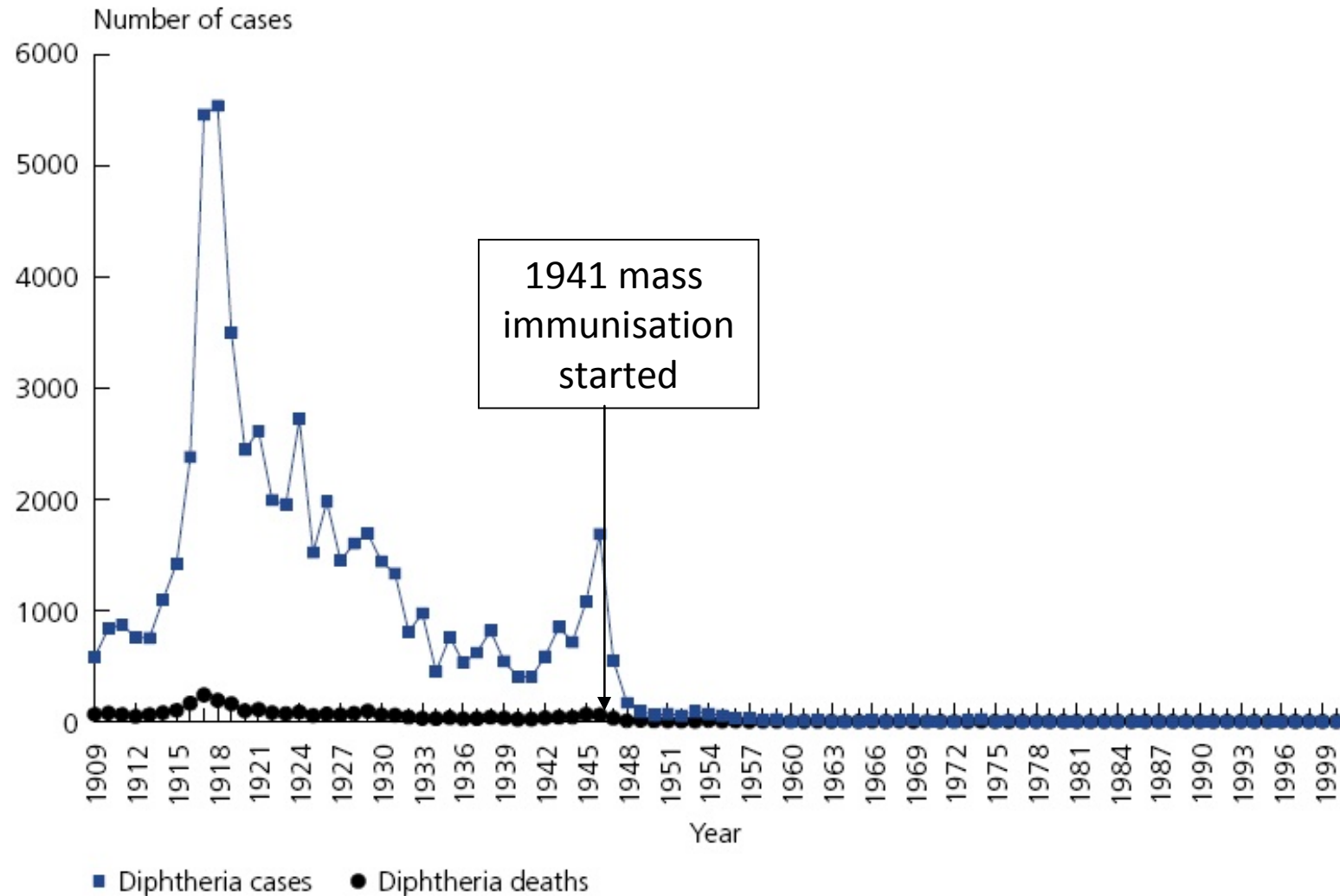


- Identify that pertussis remains a big problem globally
- Describe the main reasons New Zealand has a bigger pertussis problem than Australia, the UK and the USA
- Recognise why pertussis remains a diagnostic challenge
- State why our immunisation policy should remain focussed on prevention of severe disease in infants

Why our immunisation policy should
remain focussed on prevention of
severe disease in infants

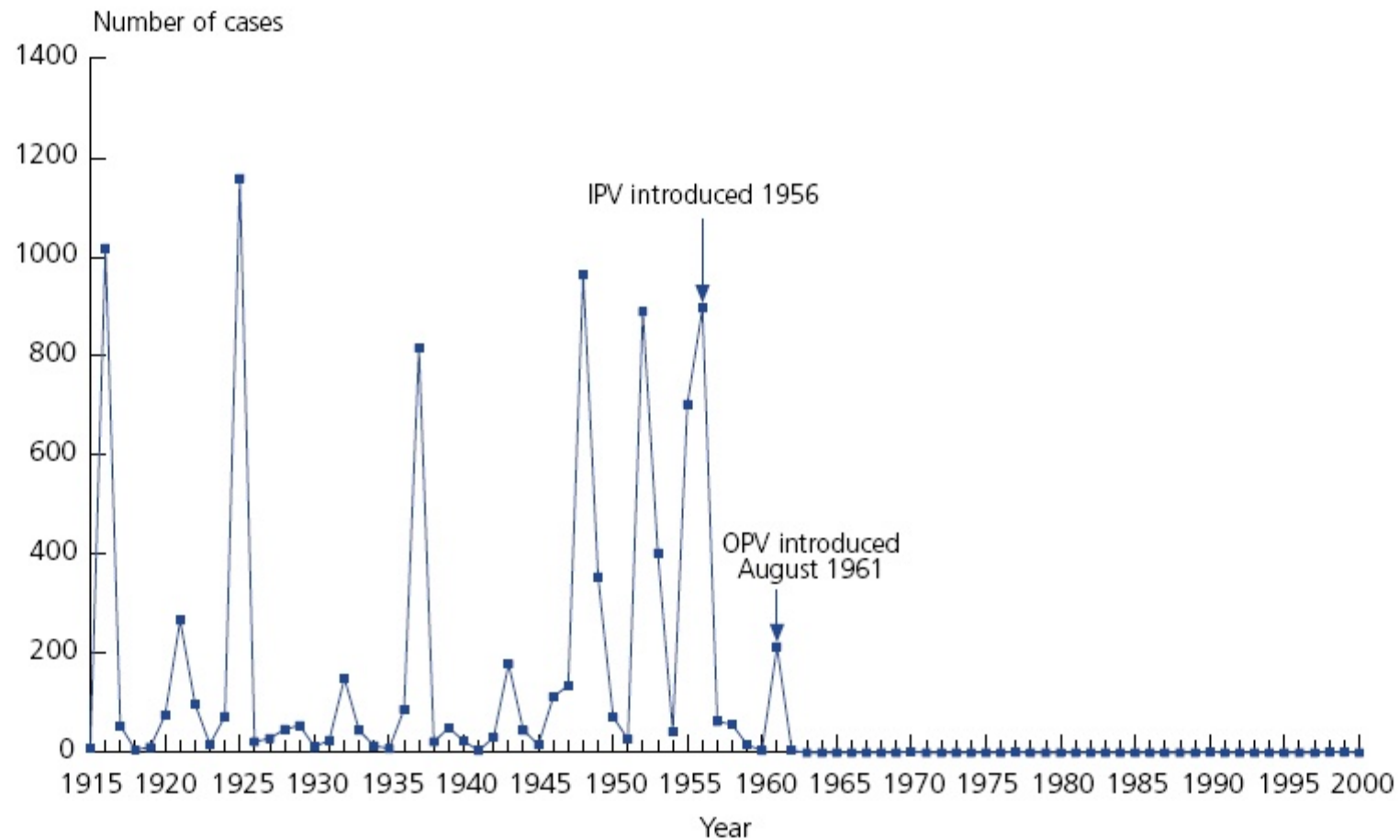
Because pertussis is not the
same as other vaccine
preventable diseases

Diphtheria cases in New Zealand 1909-2000

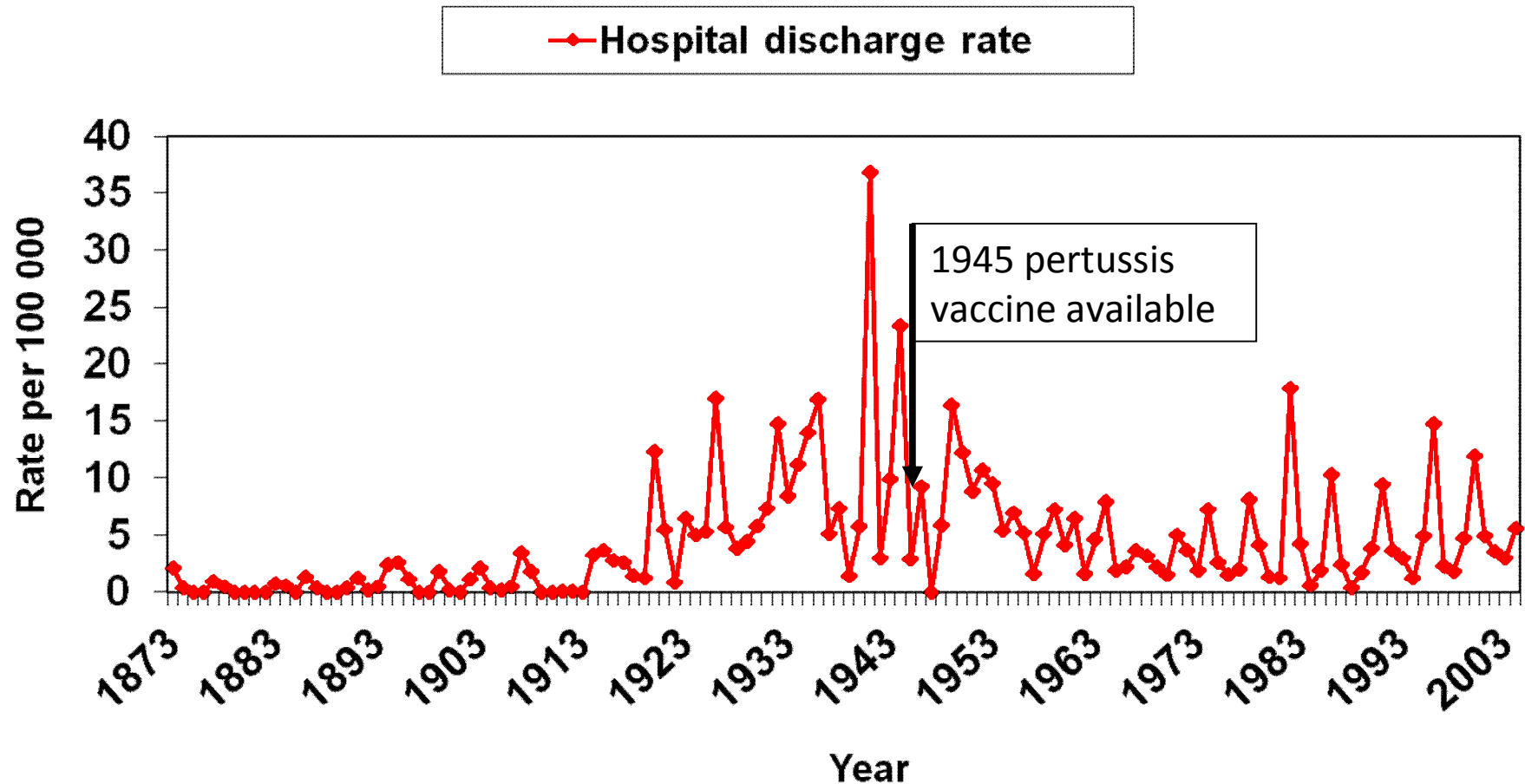


Ministry of Health; *Immunisation Handbook 2011*. Wellington: Ministry of Health; 2011

Polio cases in New Zealand 1915-2000



Pertussis hospital discharge rate in New Zealand 1873 to 2009

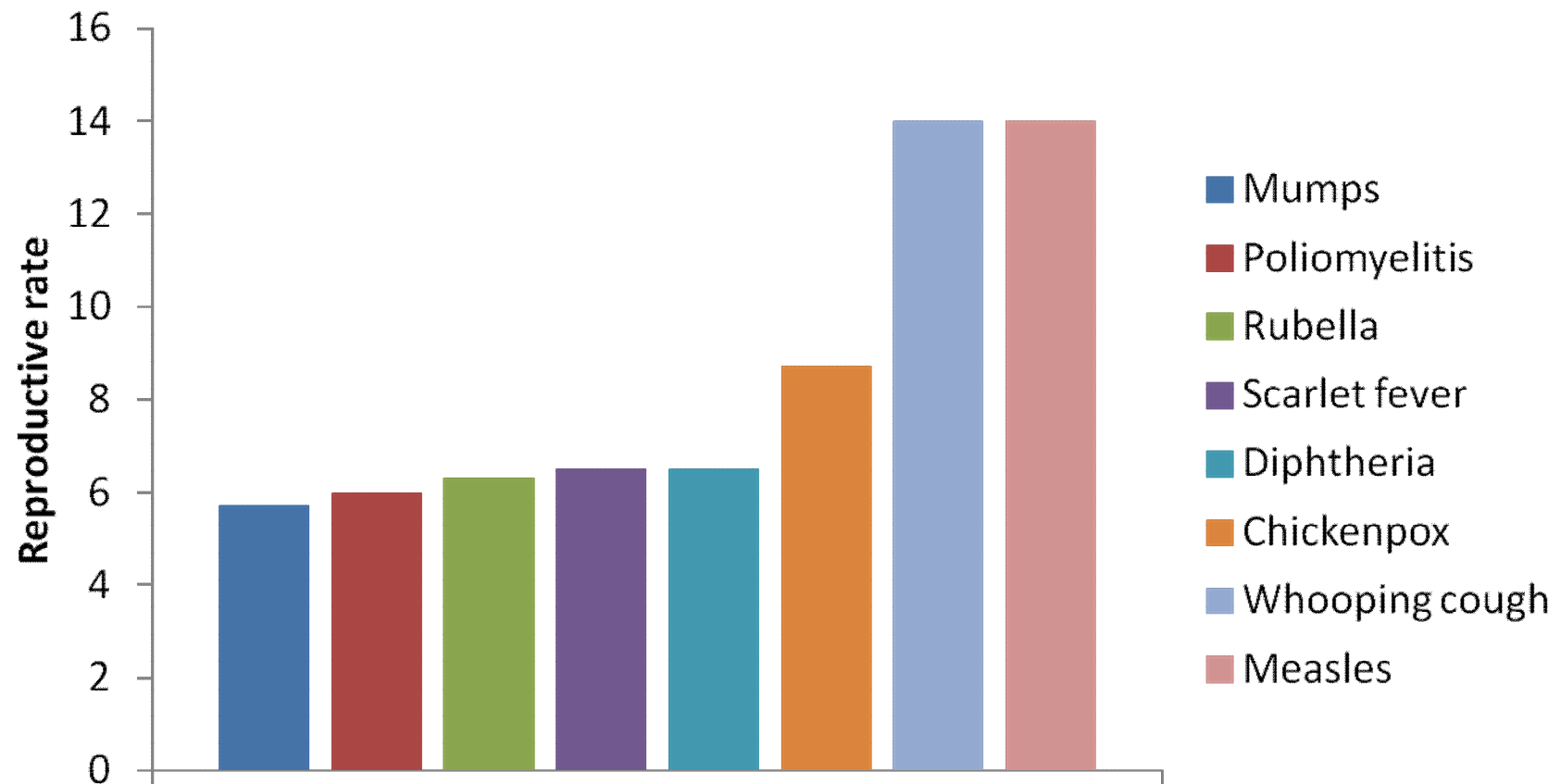


Pertussis is contagious



The reproductive rate of various infections

Reproductive rate = expected number of secondary cases caused by an infectious individual



The exquisite vulnerability of the young



**In the USA during the 1940s pertussis
resulted in more infant deaths
than measles, diphtheria, poliomyelitis
and scarlet fever
combined**

Young infants remain vulnerable

- A recent (2010) epidemic in California killed eight infants
- Risk factors for death (US)
 - Age < 2 months
 - Low birth weight
 - Female gender
 - 5 minute apgar score < 8
 - Maternal education < 12 years



Roehr B. *BMJ* 2010;341:c4627.

Haberling DL, Holman RC, Paddock CD, Murphy TV. *PIDJ* 2009;28:194-8

Young infants remain vulnerable

Six out of 10 infants who get pertussis will need to be hospitalised

One in 10 of infants who are hospitalised with pertussis require intensive care

One in 6 infants who are admitted to intensive care with pertussis will die or be left with lung or brain damage

Cortese MM et al. *Pediatrics* 2008;121:484-92.

Somerville RL, Grant CC, et al. *J Paed Child Health* 2007;43:617-22.

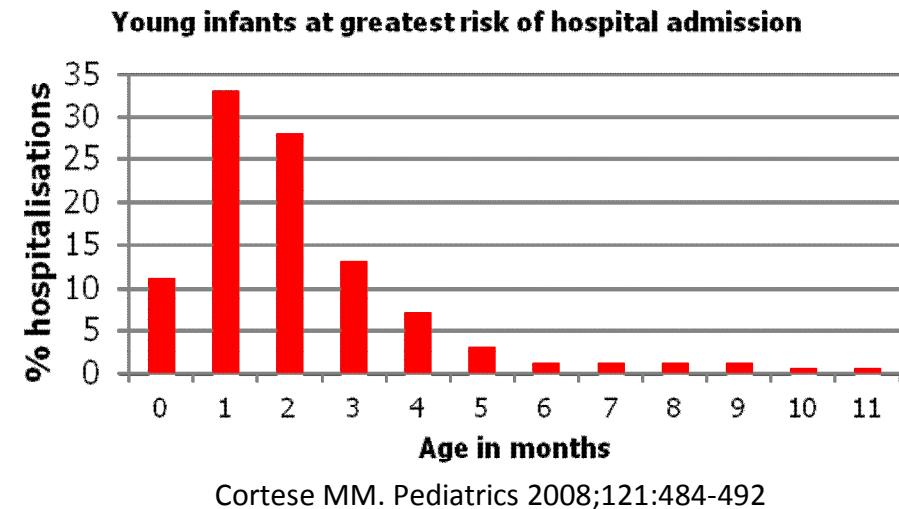
Surridge J, Segedin ER, Grant CC. Pertussis requiring intensive care. *Arch Dis Child* 2007;92:970-5.

A photograph of a sunset sky with three birds flying in a shape that resembles a smile. The birds are silhouetted against the orange and red glow of the setting sun. The sky transitions from a deep orange near the horizon to a dark blue at the top. In the foreground, there are dark silhouettes of trees and a body of water.

For all of these reasons prevention of
severe disease in infants requires good
timing

Better control is dependent upon timeliness

- Timeliness
 - Timeliness
 - Timeliness
 - Timeliness
 - » Timeliness
 - Timeliness
 - Timeliness
 - Timeliness

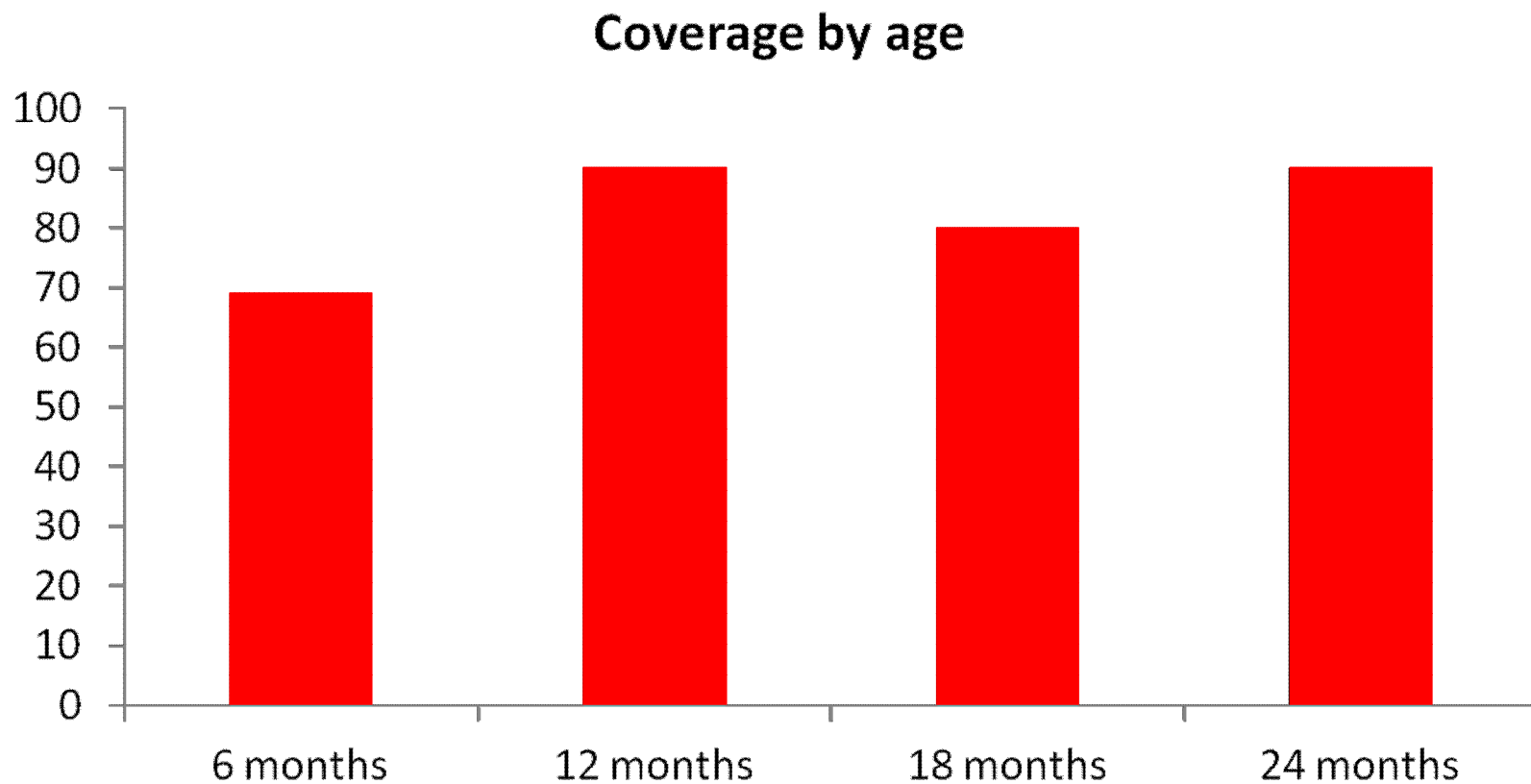


NZ Immunisation coverage and timeliness at age 1 year



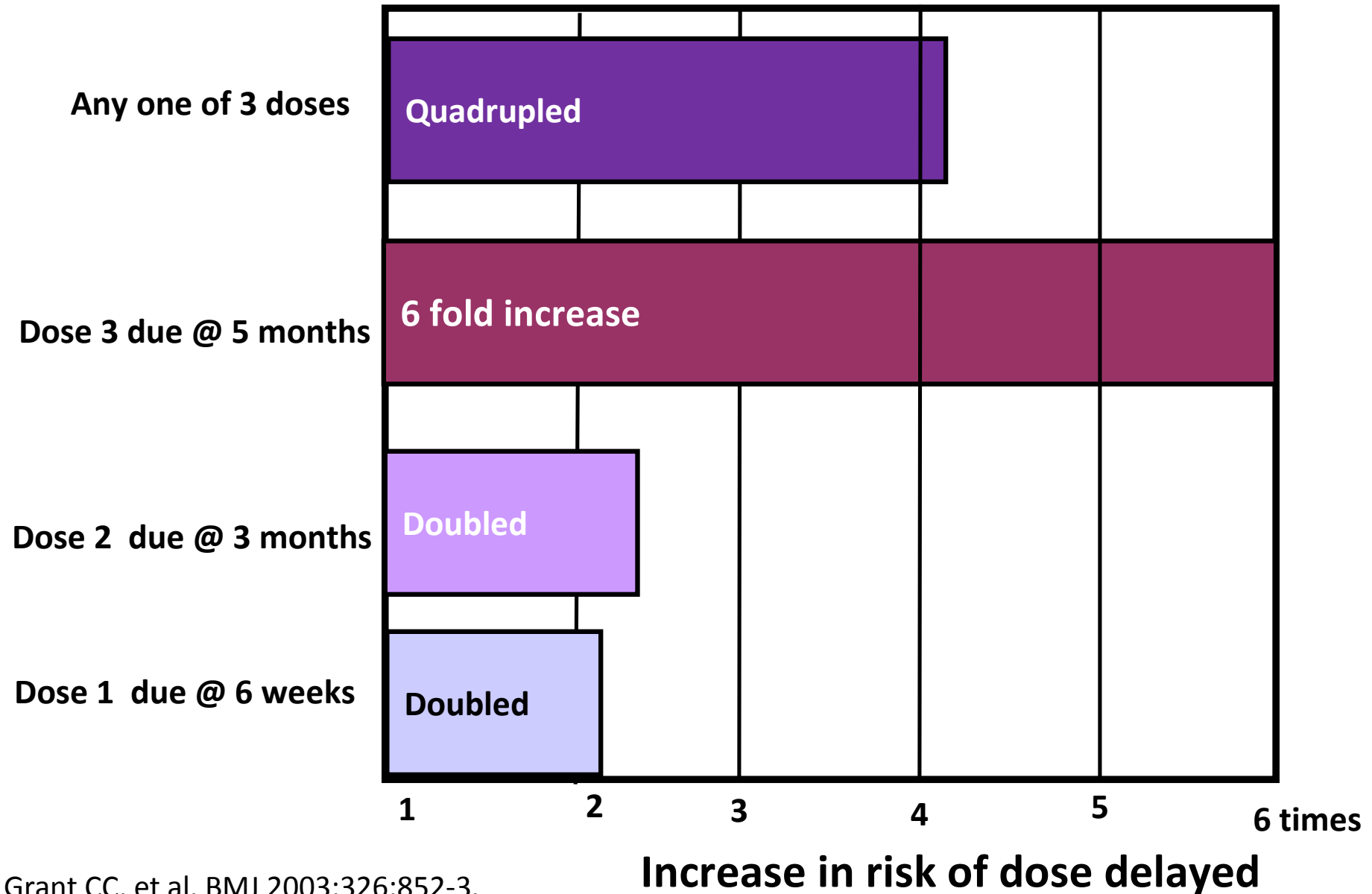
Ministry of Health National Immunisation Coverage Survey 2005

National immunisation coverage data by age for 3 months to end June 2011



[http://www.health.govt.nz/our-work/preventative-health-wellness/
immunisation/immunisation-coverage/national-and-dhb-immunisation-data](http://www.health.govt.nz/our-work/preventative-health-wellness/immunisation/immunisation-coverage/national-and-dhb-immunisation-data)

Delayed immunisation and risk of pertussis hospitalisation in infants



The best timing in the world can't
protect the youngest infants



Global pertussis initiative: Pertussis control strategies

1. Reinforce and/or improve current infant and toddler immunisation strategies
 - Direct protection
2. Create a cocoon of contacts who are immunised and hence less able to spread pertussis to infants
 - Indirect protection

Forsyth KD et al. New pertussis vaccination strategies beyond infancy: recommendations by the global pertussis initiative. Clin Infect Dis 2004;39:1082-9



Cocoon immunisation



Universal adult immunisation?

Could change dT to dTap

- Coverage not high enough
- Dose interval not frequent enough
- 45 years and 65 years

Minimum interval gap between receipt of Td and Tdap vaccine has been removed



Selective immunisation of health care workers



Selective immunisation of health care workers

- Health care workers are at increased risk of pertussis
- Outbreaks in maternity wards, neonatal units and in outpatient settings
- Fatalities occur as a result
- Benefit for the hospital is estimated to be 2.4 times the dollar amount spent on vaccinating health care workers

weekdays

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Whooping cough scare at Middlemore Hospital

Whooping cough scare at Middlemore Hospital

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By: [Juliette Sivertsen](#) | [Latest Health News](#) | Thursday May 10 2012 13:32

At least 150 mothers and their babies may have been exposed to whooping cough at Middlemore Hospital.

Auckland Regional Public Health Service has confirmed a health professional in maternity services has been diagnosed with the infectious disease.

Clinical Director Dr Julia Peters says they've tried to identify all people who have been close contacts with the case.

"Contacting all the families by phone and letter, also all the general practitioners and all the relevant local maternity providers so that we are sure that people have received the advice they



◀ Larry's Memo: May 15 ▶

Advertisement



Cocoon immunisation



Recommended now funded in some DHBs



Recommended but not funded

Recommended but not funded



Recommended but not funded



Recommended but not funded



Recommended but not funded



Recommended but not funded

Upon completion of this
presentation you should be able to:

State why our immunisation policy
should remain focussed on prevention
of severe disease in infants

Why our immunisation policy should remain focussed on prevention of severe disease in infants

- **Pertussis is not the same as other vaccine preventable diseases**
 - Pertussis vaccines prevent severe disease
 - Pertussis vaccines prevent infection less completely
- **Pertussis is very infectious**
 - As infectious as measles
 - Twice as infectious as most other vaccine preventable diseases
- **Young infants are exquisitely vulnerable to pertussis**
 - This has always been the case
 - Even today they can quickly get into a dangerous pertussis space
 - Because of this a combination of approaches is recommended
 - Complete immunisation
 - Timely immunisation
 - Cocoon immunisation

Upon completion of this presentation you should be able to:

- **Identify that pertussis remains a big problem globally**
 - Among the 10 leading causes of child death
 - Epidemic disease remains a global threat
 - Recent epidemics in Australia, USA
 - Current epidemic in New Zealand
- **List the main reasons New Zealand has a bigger pertussis problem than Australia, the UK and the USA**
 - Low coverage of the primary immunisation series at least since the 1990s
 - Late introduction of booster doses
 - Scheduling changes that have been driven by concerns about vaccine safety more than disease control

Upon completion of this presentation you should be able to:

Recognise why pertussis remains a diagnostic challenge

- Babies with pertussis
 - Have atypical and rapidly evolving disease
- School aged children with pertussis
 - Have vaccine modified disease
- Adolescents and adults with pertussis
 - Pertussis not considered
 - Have vaccine modified disease

State why our immunisation policy should remain focussed on prevention of severe disease in infants

- Pertussis is not as vaccine preventable as other vaccine preventable diseases
- Pertussis is very infectious
- Infants are exquisitely vulnerable to severe pertussis

Next Steps...

- Ensure infants / adolescent vaccines received on time
- Check whether you (and practice staff) have had a recent booster for whooping cough
- Remind new mothers and mothers to be and their families (grandparents etc.) about disease transmission and the importance of whooping cough boosters

Boostrix®

Combined diphtheria-tetanus-acellular pertussis (dTpa) vaccine

Boostrix is the only dTpa vaccine available in a pre-filled syringe^{1,2}

Administration: Boostrix is administered by deep intramuscular injection.
THE VACCINE SHOULD NEVER BE ADMINISTERED INTRAVENOUSLY.



Boostrix is well tolerated; in clinical trials, common side effects were mild and transient. They included fever, malaise, fatigue, headache, irritability, loss of appetite, vomiting, diarrhoea, dizziness, and local reactions such as pain, redness, bruising, itching, or swelling at the injection site.¹

1 GlaxoSmithKline New Zealand. *Boostrix*® Data Sheet. GSK NZ; 2011. Available at www.medsafe.govt.nz/profs/datasheet/b/Boostrixinj.pdf

2 Sanofi-aventis New Zealand. Adacel Data Sheet. Sanofi-aventis NZ; 2007. Available at www.medsafe.govt.nz/profs/datasheet/a/adacelinj.pdf

Boostrix[®] (combined diphtheria-tetanus-acellular pertussis (dTpa or Tdap) vaccine) is available as an injection. A 0.5 mL dose contains not less than 2.5 LfU of diphtheria toxoid, not less than 5 LfU of tetanus toxoid, and three purified *Bordetella pertussis* antigens (8mcg of pertussis toxoid, 8 mcg of filamentous haemagglutinin, and 2.5 mcg of 69 kDa outer membrane protein). *Boostrix* is a private-purchase prescription medicine for booster vaccination against diphtheria, tetanus, and pertussis in individuals aged 10 years and older – a prescription charge will apply. Adequate data on use during pregnancy or breastfeeding are not available; therefore prescribing decisions should be based on the possible risks and benefits for each patient. **Contraindications:** known hypersensitivity to any component of the vaccine, encephalopathy after previous pertussis vaccination, or transient thrombocytopenia or neurological complications after previous vaccination against diphtheria and/or tetanus. **Precautions:** do not administer intravenously; ensure medical treatment is readily available in case of rare anaphylactic reaction following administration. **Common side effects** include fever, malaise, fatigue, headache, irritability, loss of appetite, vomiting, diarrhoea, and local reactions such as pain, redness, bruising, itching, or swelling at the injection site. Before prescribing *Boostrix*, please review the full Data Sheet at www.medsafe.govt.nz. *Boostrix* is a registered trade mark of the GlaxoSmithKline group of companies. Marketed by GlaxoSmithKline NZ Limited, Auckland. TAPS DA5312IG/NZ/BOO/0009/12