Changing epidemiology of vaccine preventable diseases in New Zealand

Sarah Radke PhD, MSPH
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Why vaccines?

“Only clean water and antibiotics have had an impact on childhood death and disease that is equal to that of vaccines”

-World Health Organization
Smallpox

Source: BBC.co.uk
Smallpox

- Since 10,000 BC
- Killed approx 400,000 Europeans annually during 18th Century
- 1/3 of all blindness, 20-80% fatality rate
- 20th century around 300-500 million deaths
- Last case in NZ in 1925
- Last 2 cases in the world in 1978
- Global eradication declared in 1980
Polio
Global Polio Eradication Initiative

- 1988 41th World Health Assembly 166 Member States
- Resolution for worldwide eradication of polio
Polio in 2014

Wild Poliovirus - 2014
01 January - 09 September

Excludes vaccine derived polioviruses and viruses detected from environmental surveillance.

Source: WHO
Polio cases in New Zealand 1915-1962

1956
Age-targeted vaccination began

1960-1962
Vaccine offered to 6m – 21y then to adults

Source: ESR
Since 1962
- no cases of ingeniously acquired polio
- 4 confirmed cases of VAPP
- 2 probable cases of VAPP

Source: ESR

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Polio deaths in New Zealand 1946-2009

Roll out of vaccine commencing 1956

Source: ESR
Tetanus

Source: Immunisation Handbook 2014
Tetanus deaths in New Zealand, 1945-2012

- **1940-1945**: Vaccine available, Voluntary uptake
- **1958**: Vaccine added to National Immunisation Schedule

Source: NZ Health Information Services
Recipe for vaccine-control of infectious diseases

Vaccine Effectiveness

- Duration of immunity from disease
- Basic reproduction number of infection (infectiousness)
- Indirect protection? (Non-vaccine control measures)
- Duration of immunity from vaccine
- Vaccine coverage
- Efficacy
Pertussis

Source: Anusha Ganeshalingham, Paediatric Intensive Care Specialist, Starship Hospital
Number of pertussis notifications and hospitalisations by calendar month-year, New Zealand, 1998-2014

Notifications (<1 year of age)

Notifications (all ages)

Hospitalisations (all ages)

Note: Includes confirmed, probable, suspect cases and notifications still under investigation.

Source: ESR 2014
Rate of pertussis notification (cases per 100,000 population) by age group, 1997-2014

Note: Includes confirmed, probable and suspect cases only. Rate of pertussis cases per 100,000 population calculated using mid-year population estimates.
Pertussis hospitalisations by age group
2000 – 2013, NZ

Source: Radke S et al, IMAC 2013

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## Pertussis Hospitalisations 2006 - 2012 birth cohorts

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median age in months (IQR)</td>
<td>2.3 (1.4, 4.4)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>329 (49)</td>
</tr>
<tr>
<td>Female</td>
<td>345 (51)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>285 (42)</td>
</tr>
<tr>
<td>Pacific</td>
<td>116 (17)</td>
</tr>
<tr>
<td>Asian</td>
<td>18 (3)</td>
</tr>
<tr>
<td>European</td>
<td>241 (36)</td>
</tr>
<tr>
<td>Other</td>
<td>13 (2)</td>
</tr>
</tbody>
</table>

Radke S, et al. IMAC 2013
Pertussis Hospitalisations
2006 – 2012 birth cohorts

By socioeconomic status

Radke S, et al., IMAC 2013
Baby girl's death from whooping cough was preventable – coroner

Baby girl dies in growing whooping cough outbreak.
Pertussis vaccination coverage

% immunised by 2 years of age

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Note: Includes confirmed, probable, suspect cases and notifications still under investigation.
R₀ = the expected number of secondary cases produced by a single (typical) infection in a completely susceptible population

R₀ for pertussis is between 12 and 17

Pertussis is extremely infectious

Source: Plotkin. Vaccines. 5th Edition
Pertussis infection induces imperfect immunity

- Immunity not life long
- Average adult probably experiences 2.6 cases of mild pertussis in lifetime

Pertussis vaccines induce even less perfect immunity

Pertussis vaccine efficacy

- Current aP vaccine provides around 81-85% efficacy after 3 infant doses\(^1\)
- Number and schedule of doses has changed over time in New Zealand\(^2\)

1 Greco D et al. 1996 NEJM; Edwards KM et al. 2013 Vaccines 6\(^{th}\) edition; Gustafsson L 2006 Pediatrics
2 New Zealand Immunisation Handbook 2014
Pertussis vaccine efficacy - timeliness

- Room for improvement in timeliness of vaccination
And delays are more common in the highest risk groups

% fully immunised at 6 months of age by ethnicity June 2009 to March 2014

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% fully immunised at 6 months of age by deprivation June 2009 to March 2014

Dep 1-2  Dep 3-4  Dep 5-6  Dep 7-8  Dep 9-10
Indirect protection?

- Antibody against PT prevents clinical illness
- Natural infection prevents re-colonisation for some years
- **aP vaccine does not prevent colonisation**
  Vaccinated baboons exposed to pertussis infect unvaccinated baboons and make them sick

Jason M. Warfel, Lindsey I. Zimmerman, and Tod J. Merkel. Acellular pertussis vaccines protect against disease but fail to prevent infection and transmission in a nonhuman primate model PNAS 2014 111 (2) 787-792
Measles

Source: American Academy of Pediatrics, Red Book Online Visual Library
Figure 1. Routine first measles vaccination coverage (WHO-UNICEF estimates) and measles case reports. 1980 - 2011.

WHO. Status report on progress towards measles and rubella elimination. 22 Oct 2012
Four Western Pacific countries and areas are the first in their Region to be measles-free

Steady progress on several fronts as the Region moves closer towards elimination of the disease, although significant challenges remain

News release

SEOUL, 20 March 2014 - The World Health Organization Western Pacific Region celebrates a milestone today with the announcement of measles elimination by Australia, Macao (China), Mongolia and the Republic of Korea. They are the first countries or areas in the Region to receive this distinction.

Measles kills approximately 330 people worldwide every day, mostly children under the age of five, making this a truly significant achievement as WHO Member States in the Western Pacific Region work towards the elimination of measles.

"The elimination of measles must remain a priority in order to promote equity and to reduce the high burden of mortality and morbidity caused by this disease on the world’s most vulnerable, not only in our Region but also around the world," said Dr.
Measles hospitalisations, notifications and lab confirmations, New Zealand, 1970-2012

Source: Ministry of Health and the Institute of Environmental Science and Research
2014 Surveillance Year Measles Age Specific Rates
Confirmed and Probable Cases with 95% Confidence Intervals (approx. <1 and 1-4 age group denominators)

Extract Date: 8/4/2014

2014 Surveillance Year Measles Cases by Ethnic Group
Confirmed and Probable Cases by Prioritised Ethnic Group

Extract Date: 8/4/2014


Slide content courtesy of Richard Hoskins, Medical Officer of Health. 8th April 2014
Auckland’s experience
Dec 2013 – Mar 2014
Measles cases notified in Auckland from Dec 2013

<table>
<thead>
<tr>
<th>Week Starting</th>
<th>Index (imported) case</th>
<th>Sporadic cases</th>
<th>Epilinks with sporadic/imported cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 Dec</td>
<td>Philippines</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>28 Dec</td>
<td>Philippines</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>4 Jan</td>
<td>Philippines</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>11 Jan</td>
<td>Philippines</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>18 Jan</td>
<td>Philippines</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>25 Jan</td>
<td>Vietnam/Singapore</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>1 Feb</td>
<td>Philippines</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>8 Feb</td>
<td>Philippines</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>15 Feb</td>
<td>Philippines</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>22 Feb</td>
<td>Philippines</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>1 Mar</td>
<td>London/Singapore</td>
<td>B3 Variant</td>
<td></td>
</tr>
<tr>
<td>8 Mar</td>
<td>Cambodia</td>
<td>B3 Variant</td>
<td></td>
</tr>
</tbody>
</table>

Genotype or assumed genotype based on link to known transmission chain with genotype:
- Genotype B3 - Philippines
- Genotype D8
- Genotype D9
- B3 Variant
- Other cases, untyped/awaiting typing

Slide content courtesy of Richard Hoskins, Medical Officer of Health. 8th April 2014
Measles

- Basic reproduction number of infection (infectiousness)
  - $R_0$ between 12 and 18

- Vaccine coverage
  - Cold chain issues in 2004
  - Andrew Wakefield autism scare

- Duration of immunity from vaccine
  - Life-long immunity

- Duration of immunity from disease
  - Life-long immunity

- Efficacy
  - Very efficacious (>95%)
  - Currently 2 doses at 15m and 4y of age
  - Timeliness by 2y of age improved

- Indirect protection?
  - Yes

- Non-vaccine control measures
  - Difficult, b/c infectious prior to symptom onset

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The gaps have closed by the two year milestone

% Fully immunised at 2 years of age by deprivation June 2009 to March 2014

% Fully immunised at 2 years of age

Dep 1-2
Dep 3-4
Dep 5-6
Dep 7-8
Dep 9-10

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% Fully immunised at 2 years of age
by ethnicity June 2009 to March 2014

NZE & Other  Maori  Pacific  Asian
Key messages

• Measles
  – We need to get the cohort with low immunisation coverage vaccinated
  – We need to reach our 95% coverage target for infants - and maintain it.

• Pertussis
  – Very challenging
  – Protecting youngest infants with maternal immunisation
  – Ultimately, we need a better vaccine