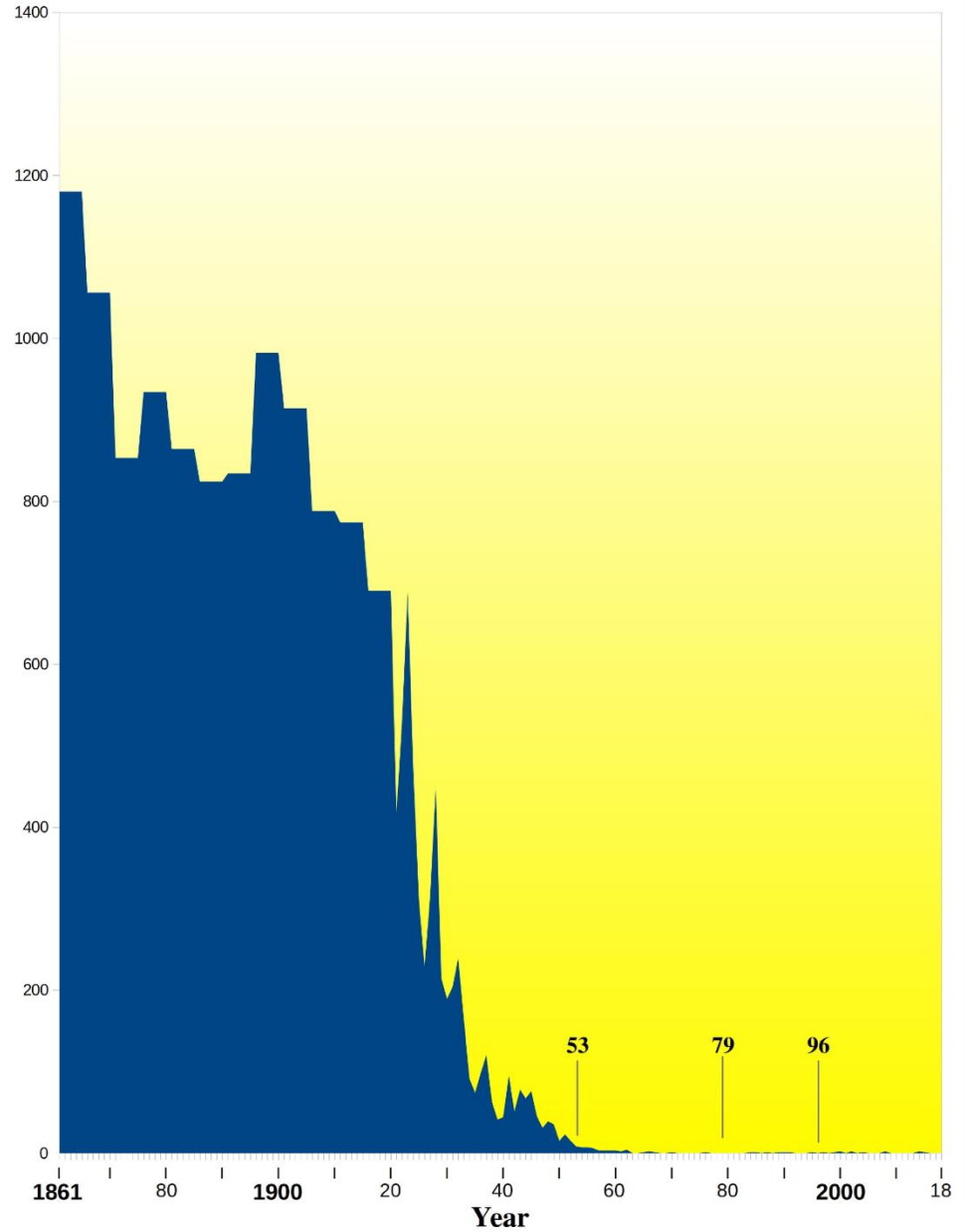
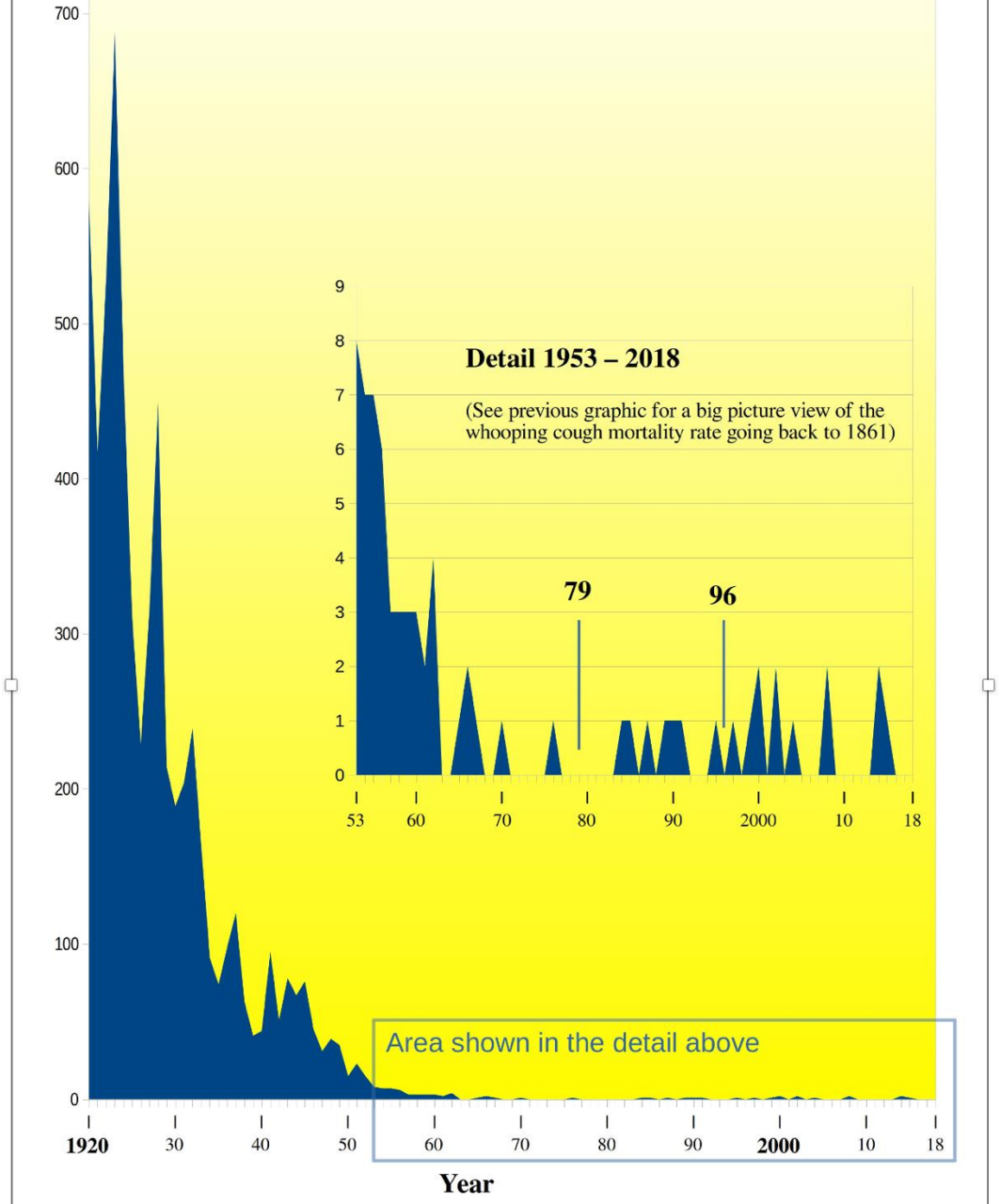


Graph 17.5: Sweden whooping cough deaths from 1861 to 2018.



Graph 17.6: Sweden whooping cough deaths from 1920 to 2018; Detailed view 1953 to 2018.

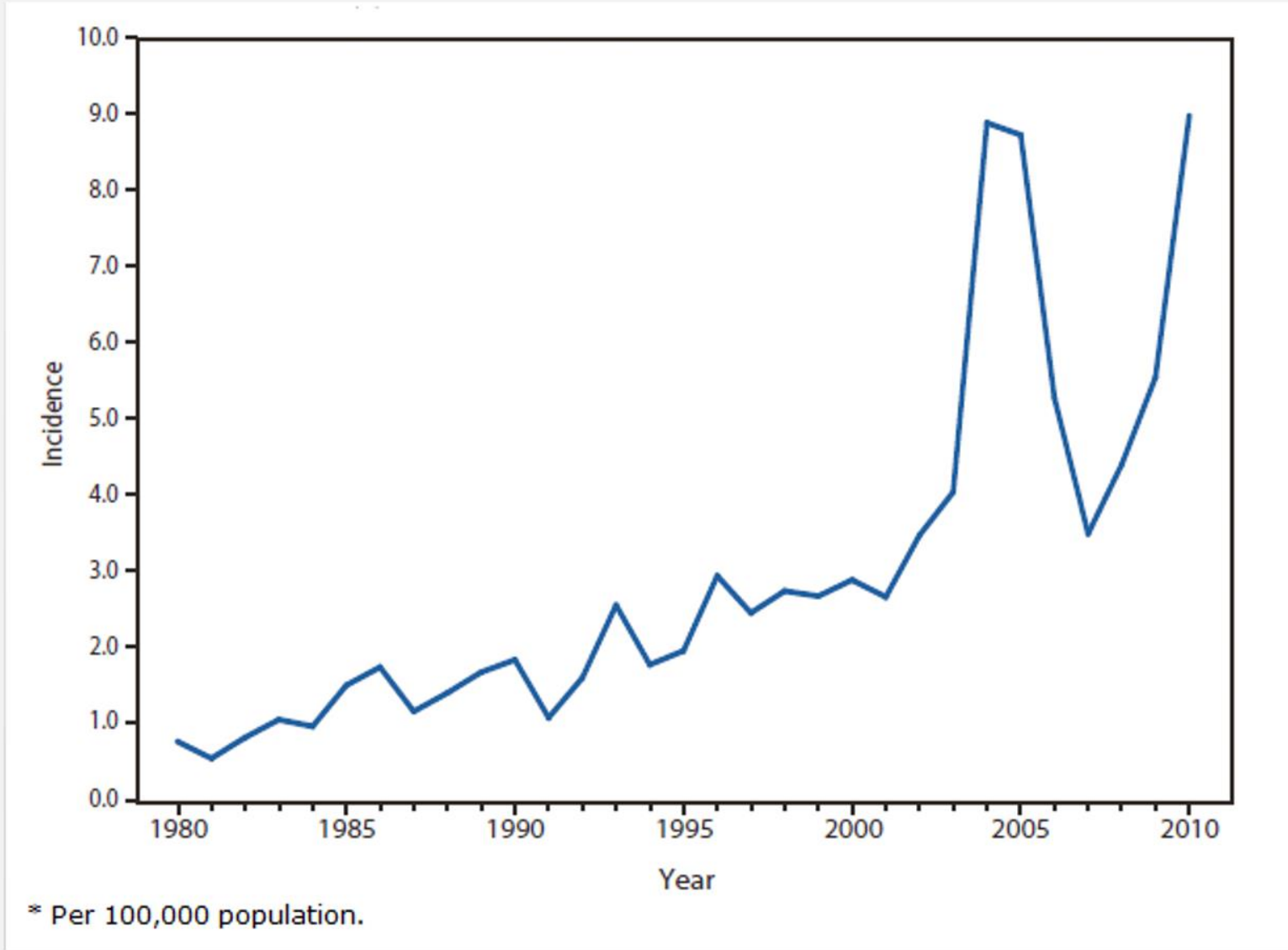


Figure 17.1: United States pertussis incidence by year from 1980 to 2010.

The 2020 New Zealand Immunisation Handbook[71] has this graph:

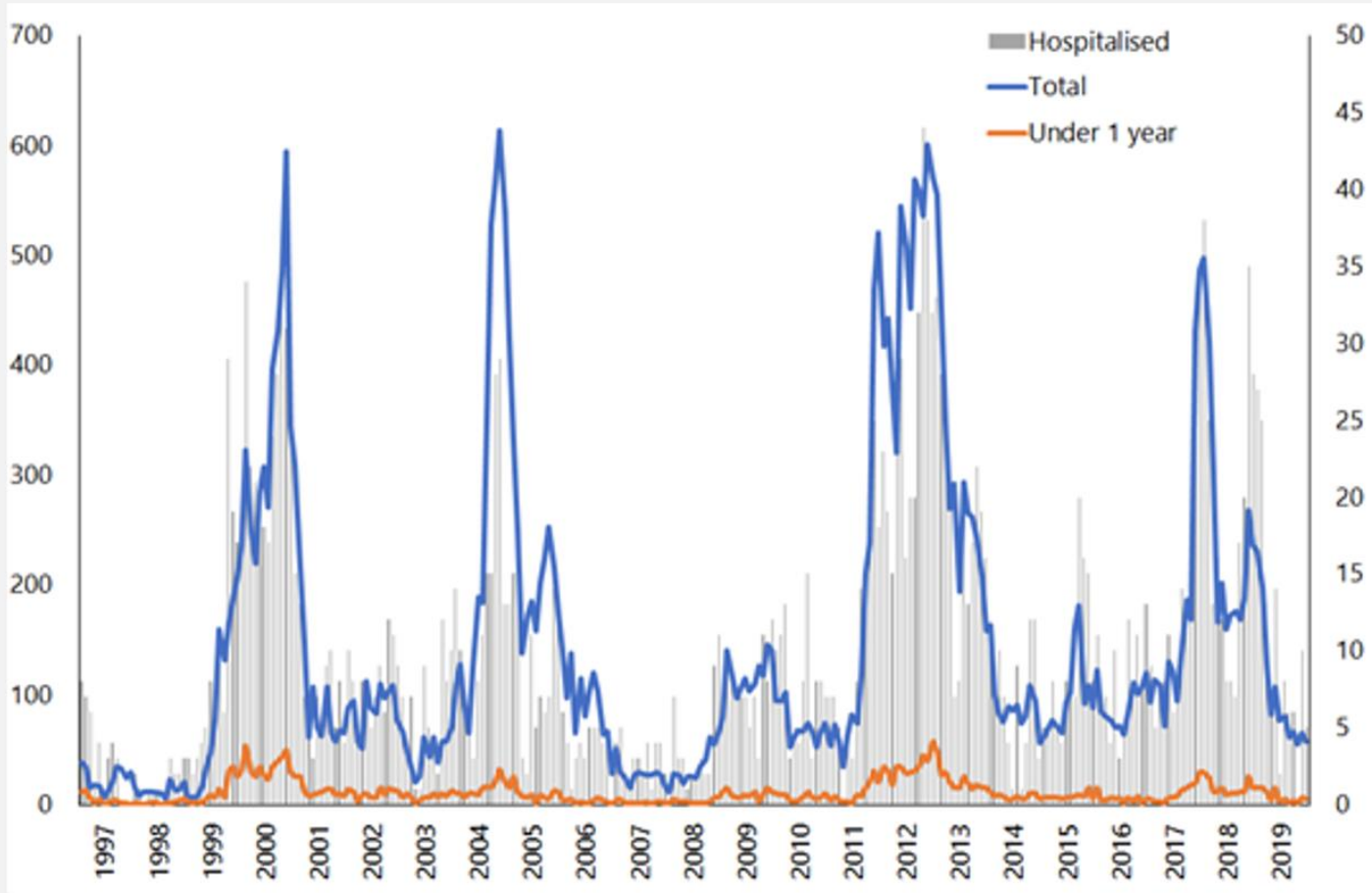


Figure 17.2: New Zealand Pertussis notifications and hospitalizations, 1997–2019.

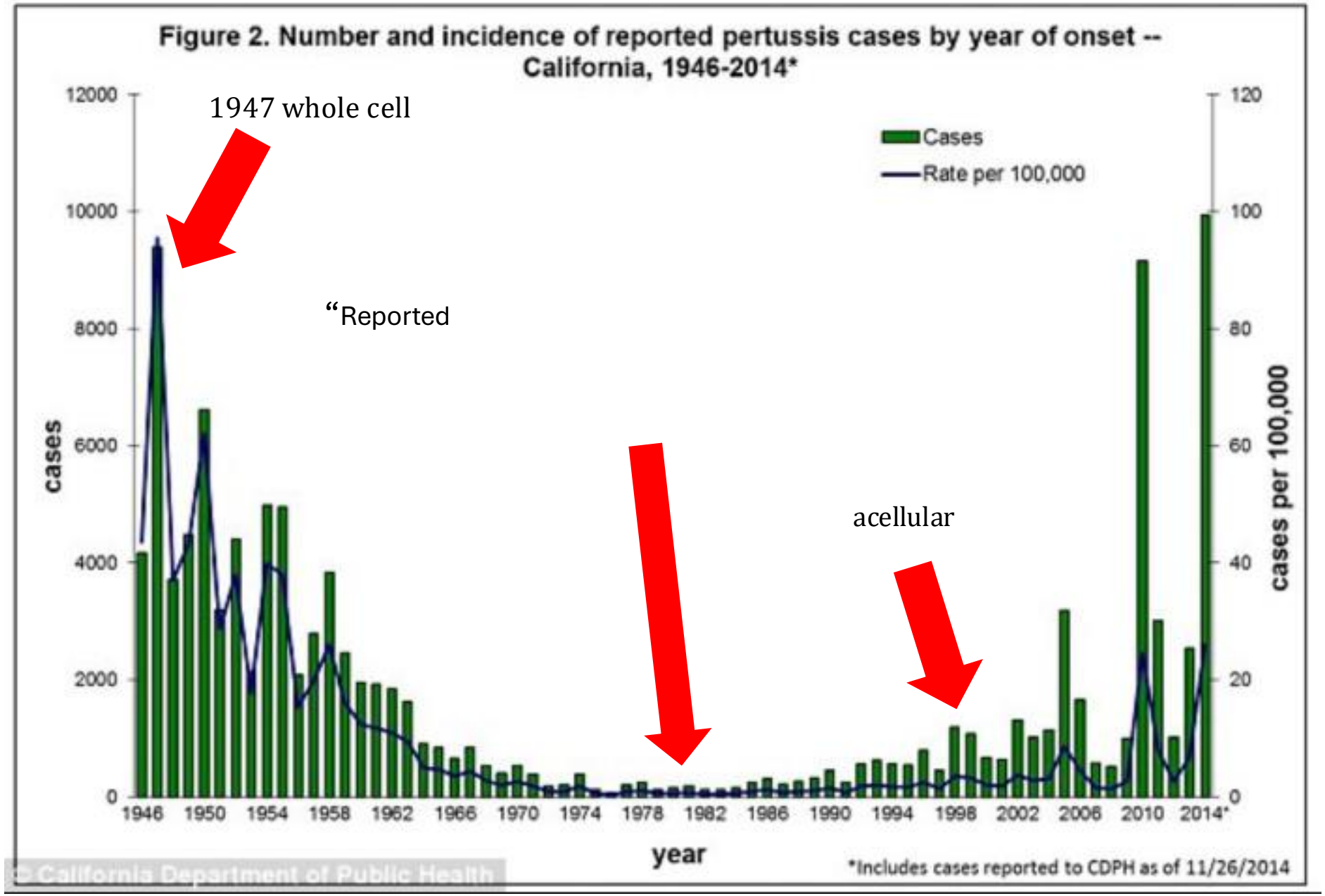
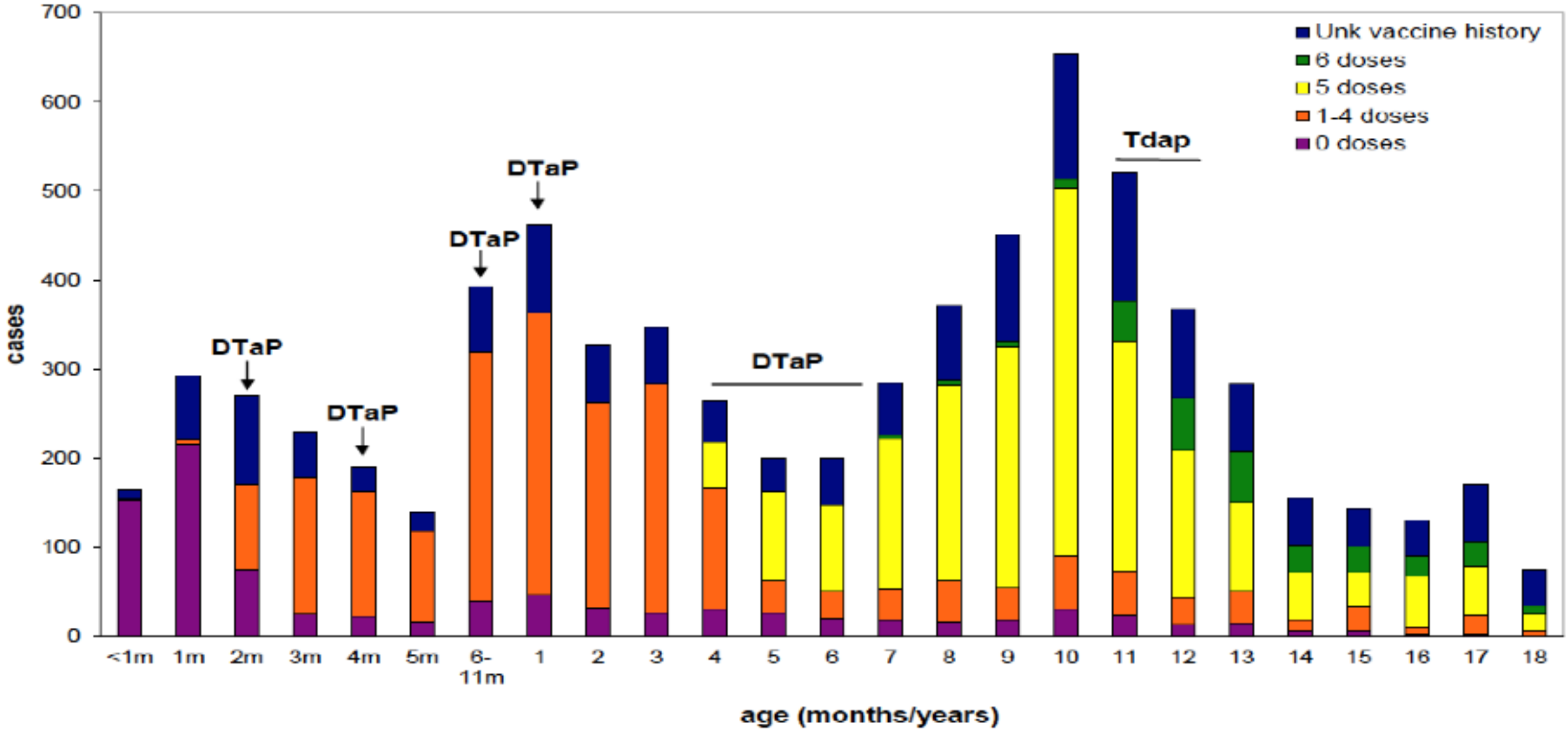
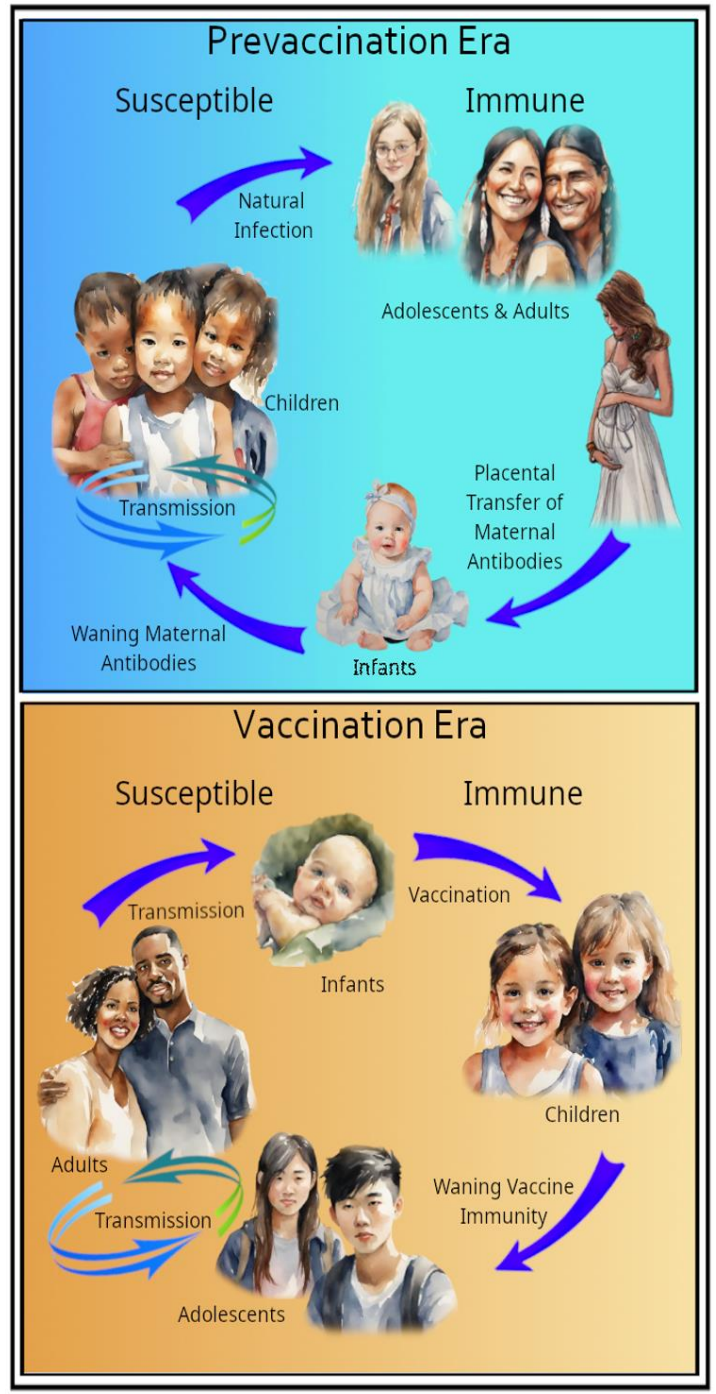


Figure 2. Number and incidence of reported pertussis cases by year of onset -- California, 1946-2014*
1947 whole cell
"Reported
acellular
Cases
Rate per 100,000
cases
cases per 100,000
year
*Includes cases reported to CDPH as of 11/26/2014
© California Department of Public Health

Figure 6. Pertussis cases in children and adolescents aged 0-18 years, by vaccine history -- California, 2010




Prevaccination Era
Susceptible
Immune
Natural Infection
Adolescents & Adults
Children
Transmission
Placental Transfer of Maternal Antibodies
Waning Maternal Antibodies
Infants
Vaccination Era
Susceptible
Immune
Transmission
Vaccination
Infants
Children
Adults
Transmission
Waning Vaccine Immunity
Adolescents

In 2000, Weingart[87] et al. pointed out that there was:

...no evidence that acellular vaccines promoted antibody-dependent killing by complement or enhanced phagocytosis by neutrophils . . . and for two individuals (3-Hi and FHA-Hi), immunization cause a statistically significant loss in complement-mediated killing... In summary, booster immunization of adults with acellular pertussis vaccines was not found to increase bactericidal activity over preimmunization levels. Identifying ways to promote bactericidal immune responses might improve the efficacy of acellular pertussis vaccines.

In unvaccinated convalescent children IgG1 and IgG3 were prevalent, whereas in children immunized with two different aP vaccines, both healthy and convalescent, IgG1, IgG2, and IgG4 antibodies were mainly produced.

Diavatopoulos 2017
PMID: 28289059

What Is Wrong with Pertussis Vaccine Immunity?

Why Immunological Memory to Pertussis Is Failing

Dimitri A. Diavatopoulos[1] and Kathryn Margaret Edwards[2,3]

[1]Laboratory of Pediatric Infectious Diseases, Radboud Center for Infectious Diseases, Radboud University Medical Center, 6500 HB, Nijmegen, The Netherlands

[2]Department of Pediatrics, Vanderbilt University School of Medicine, Nashville, Tennessee 37232

[3]Vanderbilt Vaccine Research Program, Vanderbilt University, Nashville, Tennessee 37332

Reading the explanation as to what constantly increasing the IgG4 does, we are told that IgG4 can't trigger complement but does bind to the inhibitory IgG receptor FcγRIIb, which increases IgG4 **and actually restricts inflammatory responses**! That is part of the mechanism in natural immunity: sending signals to the airway system to say that the lung-associated immune system can now shut down.

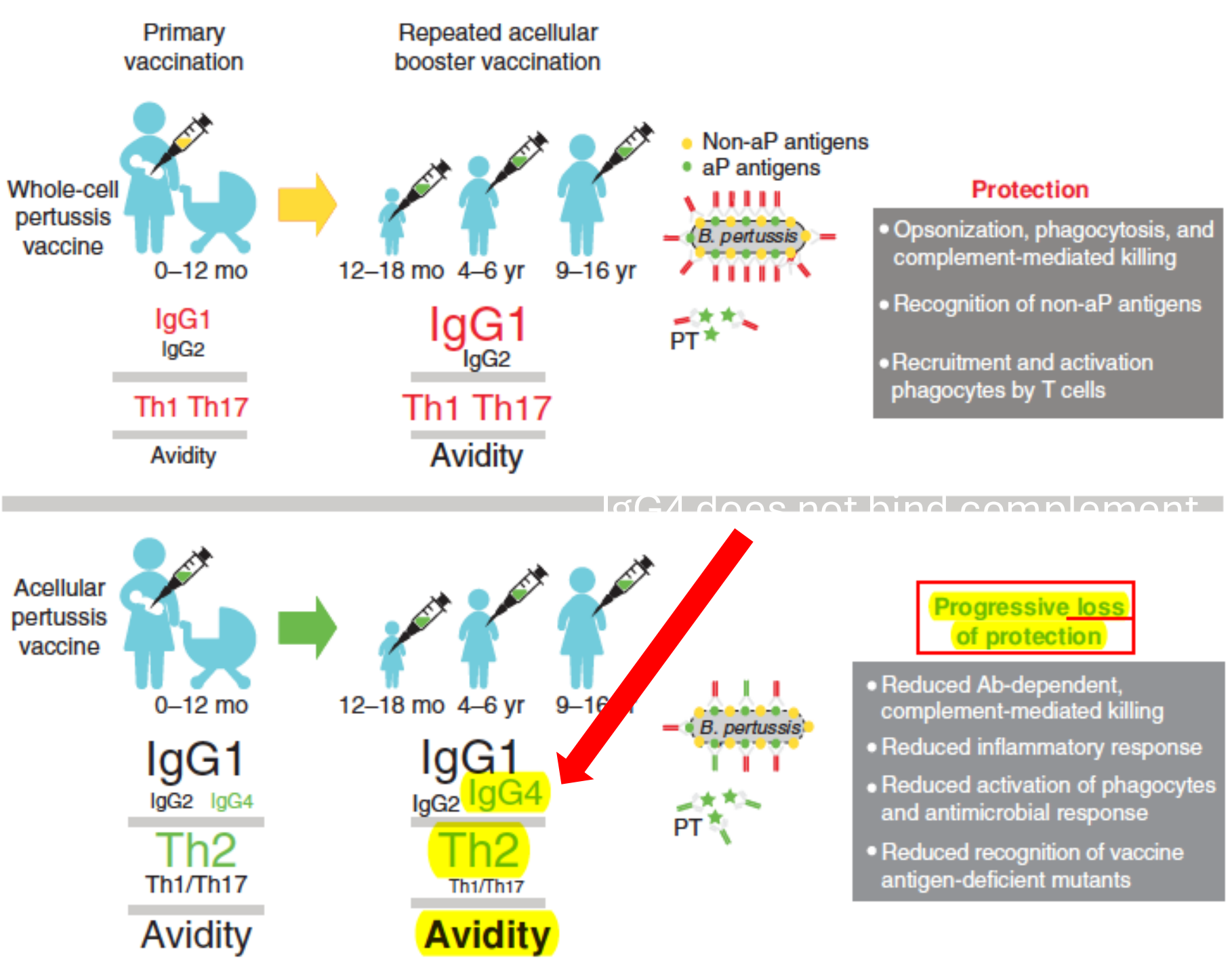
In this regard, Diavatopoulos says:

> ***Interestingly, this immune response pattern to allergen immunotherapy, closely mimics the IgG response that is observed over the course of repetitive aP vaccinations. However, for pertussis vaccination, this is likely to have unwanted consequences as an increase in IgG4 is expected to lead to a reduction in bactericidal activity.***

- *Repeated booster doses of acellular vaccine in acellular-primed children generate more antigen-specific IgG4, greater Th2 skewing, and much higher antibody avidity than acellular boosters in wholecell-primed children.*

- *Acellular-primed children have a progressive loss of protection.*

Diavatopoulos 2017 PMID: 28289059


Primary vaccination
Repeated acellular booster vaccination
Whole-cell pertussis vaccine
0–12 mo
12–18 mo
4–6 yr
9–16 yr
Non-aP antigens
aP antigens
B. pertussis
PT
IgG1
IgG2
Th1 Th17
Avidity
Protection
• Opsonization, phagocytosis, and complement-mediated killing
• Recognition of non-aP antigens
• Recruitment and activation phagocytes by T cells
IgG4 does not bind complement
Acellular pertussis vaccine
IgG4
Th2
Th1/Th17
Progressive loss of protection
• Reduced Ab-dependent, complement-mediated killing
• Reduced inflammatory response
• Reduced activation of phagocytes and antimicrobial response
• Reduced recognition of vaccine antigen-deficient mutants

". . . these finding suggest that repetitive acellular vaccination may lead to early exhaustion of cellular immunity."

Diavatopoulos 2017 PMID: 28289059

In 2019[95], veteran pertussis guru James D. Cherry weighed in on the problem of original antigenic sin, stating, ***"Because of linked-epitope suppression, all children who were primed by DTaP vaccines will be more susceptible to pertussis throughout their lifetimes, and there is no easy way to decrease this increased lifetime susceptibility."***

Today's pertussis vaccines…

- They were unnecessary, as the mortality rate had fallen almost 100% before vaccination programs began. The decrease or suspension of vaccination (e.g., in the 1970s in Sweden) did not increase deaths from pertussis.
- Impair meaningful herd immunity.
- Cannot eradicate whooping cough, which is why eradication isn't even discussed.
- Cannot prevent transmission.
- Provide defective, limited personal protection.
- Induce mutants that have higher invasive capacity.

Vaccine v. Natural Immunity

Vaccine

- Parts of bacteria
- Lots of antibody
  - Wrong shape
- Blood stimulation not lung
- IgG 2, **4**
  - Dampen Cell immunity
- Th2
- OAS

Natural immunity

- Full bacterial spectrum
- Less antibody
- More cell mediated immunity
- Lung immunity>blood
- IgG 1,3
- Th1
- No OAS

Different Effects of Whole-Cell and Acellular Vaccines on *Bordetella* Transmission

Smallridge 2014
PMID 24443545

effective. Together these results suggest that the resurgence of *B. pertussis* could be due to 2 deficiencies of the acellular vaccines: failure to protect the vaccinated individual from infection, only blunting the severity of disease, and failure to prevent the transmission of *B. pertussis*. The different effects of vaccines on

We were surprised to determine that an acellular vaccine previously found to affect pathology and colonization of the lungs was ineffective at inhibiting shedding and transmission. This finding has important implications and could partly explain the recent rise in the incidence of whooping cough cases.

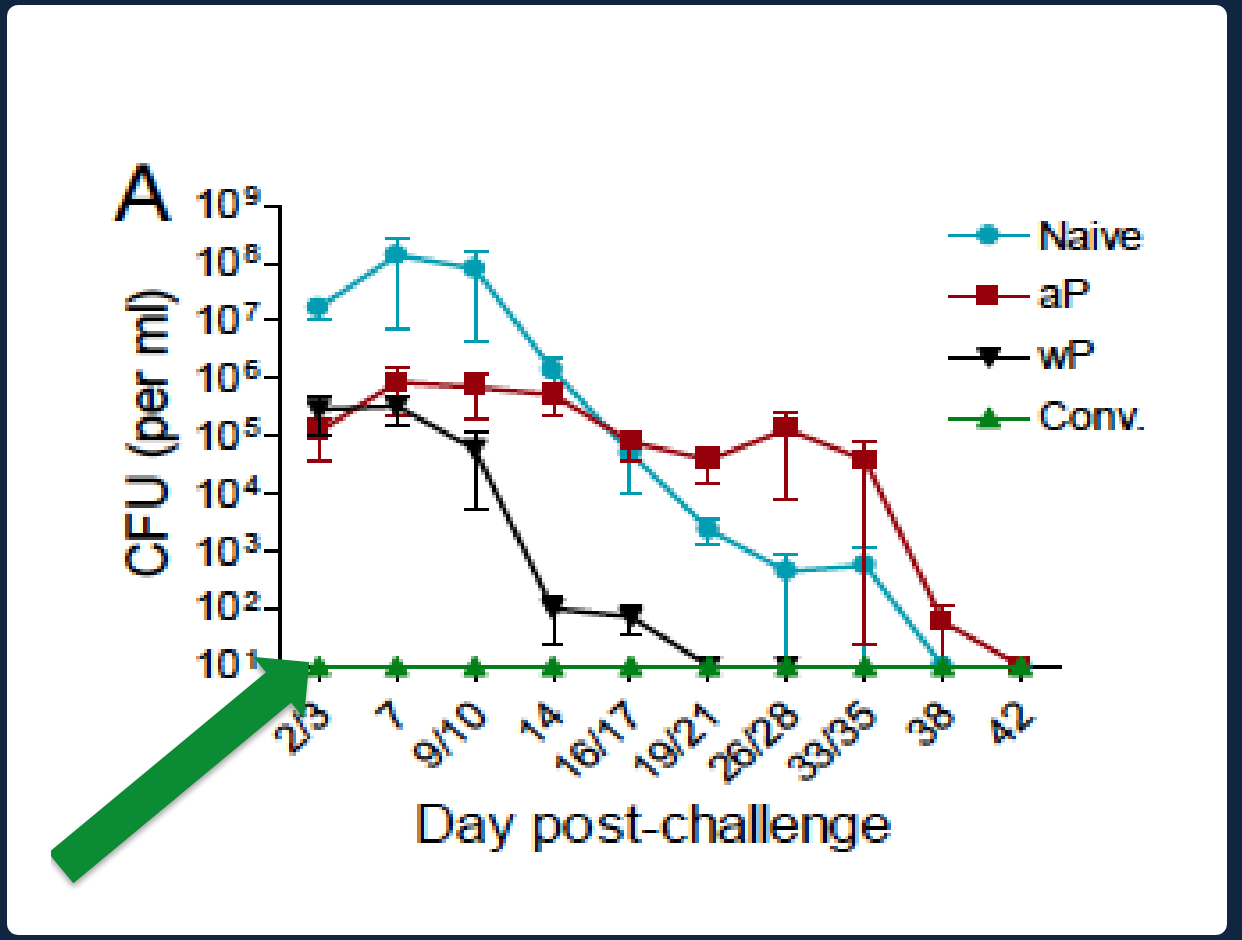
Acellular pertussis vaccines protect against disease but fail to prevent infection and transmission in a nonhuman primate model

"The observation that aP, which induces an ***immune response mismatched to that induced by natural infection, fails to prevent colonization or transmission*** *provides a plausible explanation for the resurgence of pertussis and suggests that optimal control of pertussis will require the development of improved vaccines."*

Warfel 2014 PMID: 24277828

Pertussis: Who is more likely to breed mutant strains?

Note: baboons inoculated only with normal strains



Warfel 2014 PMID: 24277828

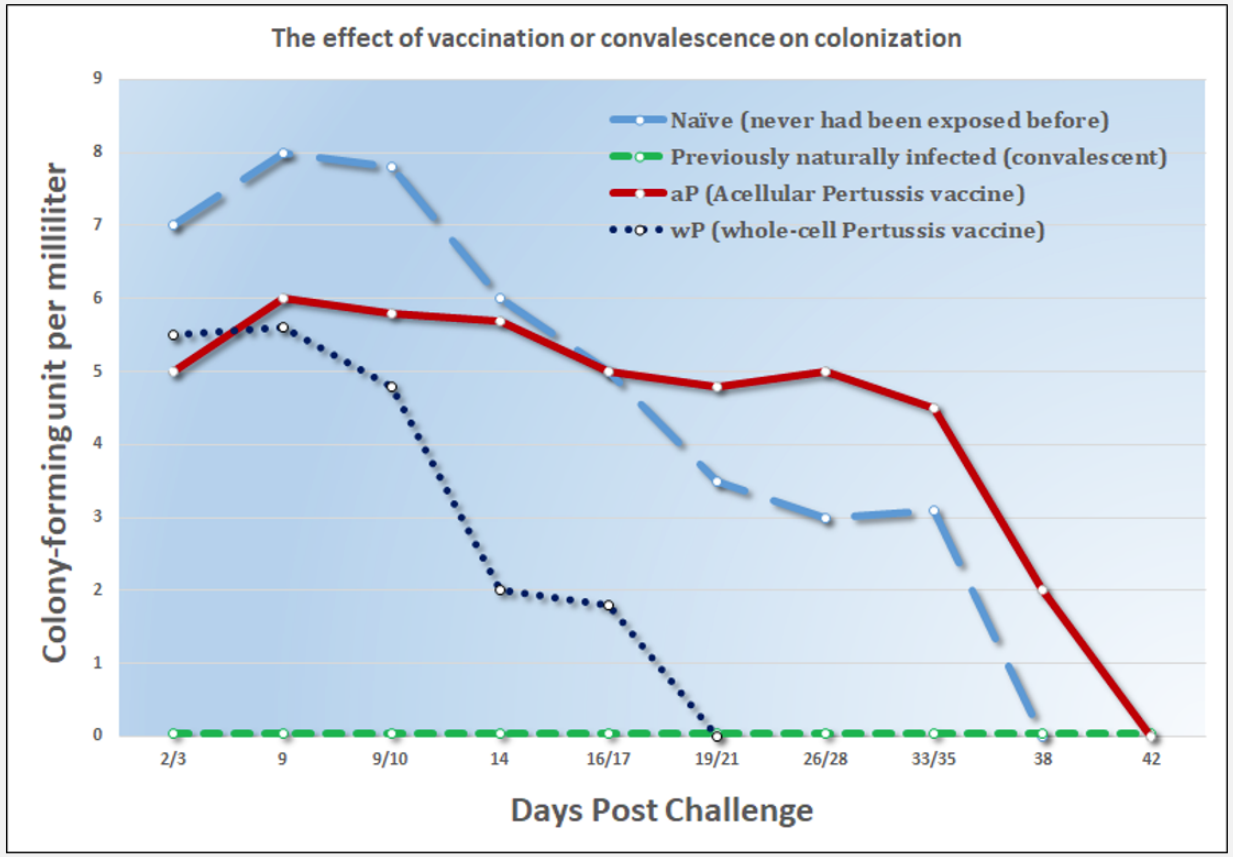


Figure 17.4: The effect of vaccination or convalescence on colonization. Naïve animals, aP-vaccinated animals, wP-vaccinated animals, and previously infected (convalescent) animals were directly challenged with B. pertussis.

A noteworthy observation on the chart is the data line denoting individuals who were previously naturally infected. The data line hugging the x-axis at the bottom of the chart denotes this group's remarkable ability to resist bacterial re-colonization, infection, and, thus, transmission.

PRN - strains

"PRN represents the most effective antigen of all aP antigens to induce functional antibodies"

- Mutant strains are missing this antigen
- This is the antigen that the vaccine makes proper antibody to

Diavatopoulos 2017 PMID: 28289059

Enhanced Invasive Ability

- Shows ***enhanced ability of the PRN- strain to invade/infect*** human dendritic cells

- *"Five hours after infection, the PRN negative (pertactin negative) strain had* ***significantly increased invasion ability.***"

Stefanelli 2008 PMID: 19579693

Volume 15, Number 8—August 2009

Mooi 2009 PMID: 19751581

Research

Bordetella pertussis Strains with Increased Toxin Production Associated with Pertussis Resurgence

Frits R. Mooi, Inge H.M. van Loo, Marjolein van Gent, Qiushui He, Marieke J. Bart, Kees J. Heuvelman,

On This Page

Abstract

Before childhood vaccination was introduced in the 1940s, pertussis was a major cause of infant death worldwide. Widespread vaccination of children succeeded in reducing illness and death. In the 1990s, a resurgence of pertussis was observed in a number of countries with highly vaccinated populations, and pertussis has become the most prevalent vaccine-preventable disease in industrialized countries. We present evidence that in the Netherlands the dramatic increase in pertussis is temporally associated with the emergence of *Bordetella pertussis* strains carrying a novel allele for the pertussis toxin promoter, which confers increased pertussis toxin (Ptx) production. Epidemiologic data suggest that these strains are more virulent in humans. We discuss changes in the ecology of *B. pertussis* that may have driven this adaptation. Our results underline the importance of Ptx in transmission, suggest that vaccination may select for increased virulence, and indicate ways to control pertussis more effectively.

Pertussis epidemic despite high levels of vaccination coverage with acellular pertussis vaccine

Sala-Farre 2013
PMID: 24216286

Maria-Rosa Sala-Farré[a,*], César Arias-Varela[a], Assumpta Recasens-Recasens[a], Maria Simó-Sanahuja[b], Carmen Muñoz-Almagro[c], Josefa Pérez-Jové[b]

Conclusion: "*Despite high levels of vaccination coverage pertussis circulation* ***cannot be controlled at all.***"

The results question the efficacy of the present Immunization programmes

Today's pertussis vaccines

- Impair meaningful HERD immunity
- Cannot eradicate whooping cough
- Cannot prevent transmission
- Provide defective, limited personal protection
- Yield to mutants that have higher invasive capacity