

# National Pertussis Workshop

*Strategies to prevent severe pertussis in the next decade*

25 –26 August 2011

Novotel on Darling Harbour





# WELCOME

25 August 2011

Dear Participant

It is our pleasure to welcome you to the National Pertussis Workshop focusing on prevention of severe pertussis in very young infants. We are fortunate to have a world-class group of Australian and overseas experts to share cutting edge information on the way forward in this important area. Thanks are due to NSW Health and the Australian Government Department of Health and Ageing for their support of the National Centre for Immunisation Research and Surveillance (NCIRS), to GlaxoSmithKline and Sanofi Pasteur for their sponsorship of the meeting, to the organising committee, and to our tireless meeting coordinators, Ms Lynda Beaumont and Ms Joanne Perkins.

We look forward to an engaging and informative two days.

Yours sincerely

The Organising Committee

Peter **MCINTYRE**, Director, National Centre for Immunisation Research and Surveillance

Stephen **LAMBERT**, Epidemiologist, Queensland Children's Medical Research Institute

Jodie **MCVERNON**, Deputy Head, Vaccine and Immunisation Research Group, University of Melbourne

Helen **MARSHALL**, Director, Vaccinology and Immunology Research Trials Unit, Women's and Children's Hospital, Adelaide

Paula **SPOKES**, Acting Manager Surveillance, Communicable Diseases Branch, NSW Health

Terry **NOLAN**, Professor and Head, Melbourne School of Population Health, University of Melbourne

Shaun **HOLMGREEN**, Medical Science Liaison – Vaccines, GlaxoSmithKline

Glen **MASON**, Medical and Regulatory Affairs Director, Sanofi Pasteur Australia and New Zealand

# PROGRAM – Day 1

THURSDAY 25 AUGUST 2011

**10:00am Arrival and welcome**

**Dr Jeremy McAnulty**  
Director, Centre for Health Protection, NSW Health

**10:30am – 12:30pm Session 1:**

**Chair Rosemary Lester**

***Epidemiologic overview of severe pertussis – how much, what is causing it?  
Australia and International***

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|---|-------------|
| 1. Is Australia the world capital of pertussis?       | P McIntyre  |
| 2. Pertussis control – has Canada got it right?       | S Halperin  |
| 3. Risk factors for death from pertussis (California) | K Harriman  |
| 4. Severity of pertussis in hospitalised children     | H Marshall  |
| 5. What do we know about source of infant infection?  | K Macartney |
| 6. Pertussis strains – do they matter?                | R Lan       |

Discussion and questions

**12:30pm – 1:30pm Lunch**

**1:30pm – 3:30pm Session 2:**

**Chair Robert Booy**

***Vaccine efficacy and vaccine schedules***

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|--|------------|
| 7. Vaccine efficacy and surrogate markers – what can the trial data tell us?       | P McIntyre |
| 8. Vaccine effectiveness and duration of immunity – field data                     |            |
| 8.1 US overview  | T Clark    |
| 8.2 Australia  | H Quinn    |
| 9. What do we know about impact of vaccines on transmission?                       | P Campbell |
| 10. Pertussis vaccine schedules – what can serosurveillance and modelling tell us? | J McVernon |

Discussion and questions

**3:30pm – 4:00pm Afternoon tea**

**4:00pm – 5:30pm Session 3:**

**Chair Helen Marshall**

***Oral poster session***



# PROGRAM – Day 2

FRIDAY 26 AUGUST 2011

## 8:00am Arrival and refreshments

### 8:30am – 10:15am Session 4:

Chair David Isaacs

#### *Cocooning – experience and cost-effectiveness*

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| 11. Experience with cocoon implementation and impact                         |            |
| 11.1 California  | K Harriman |
| 11.2 US overview   | T Clark    |
| 11.3 Australia   | S Lambert  |
| 12. Cost-effectiveness – published studies of cocooning and other strategies | A Newall   |

Discussion and questions

## 10:15am – 10:45am Morning tea

### 10:45am – 12:15pm Session 5:

Chair Peter McIntyre

#### *New strategies and new vaccines*

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| 13. Maternal immunisation – can we do it, what can we expect?                      | S Halperin |
| 14. Neonatal immunisation – can we do it, what can we expect?                      | N Wood     |
| 15. Live attenuated pertussis vaccines – are they the future of pertussis control? | C Locht    |

### 12:15pm – 1:00pm

#### *Next steps in Australia and North America – panel discussion*

Chair Terry Nolan

Panel members:

**Chris Baggoley**, Acting Australian Chief Medical Officer, Department of Health and Ageing, Canberra

**Tom Clark**, Meningitis and Vaccine Preventable Diseases Branch, Centers for Disease Control and Prevention, USA

**Scott Halperin**, Professor of Pediatrics and Microbiology and Immunology, Dalhousie University, Canada

**Kathleen Harriman**, Chief, Vaccine Preventable Disease Epidemiology Section, California Department of Public Health

**Camille Locht**, Director, Center for Infection and Immunity of Lille, Institut Pasteur de Lille, France

**Stephen Lambert**, Medical Epidemiologist, Queensland Children's Medical Research Institute, Qld

**Rosemary Lester**, Assistant Director, Health Protection, Communicable Disease Prevention and Control Unit, Deputy Chief Health Officer, Department of Health Victoria

**Helen Marshall**, Director, Vaccinology and Immunology Research Trials Unit, Women's and Children's Hospital, Adelaide

**Peter McIntyre**, Director, National Centre for Immunisation Research and Surveillance

**Jodie McVernon**, Deputy Head, Vaccine and Immunisation Research Group, MCRI and School of Population Health, University of Melbourne

## 1:00pm – 2:00pm Lunch

2:00pm Close

## SPEAKERS

### **Prof Scott Halperin**

Dr Halperin is a Professor of Pediatrics and Microbiology and Immunology at Dalhousie University and the Head of Pediatric Infectious Diseases at the IWK Health Centre in Halifax, Nova Scotia, Canada. He was educated in the United States, completing his undergraduate degree in Biology at Stanford University and his medical degree at Cornell University. His postgraduate residency training was in paediatrics at the University of Virginia and his fellowship in paediatric infectious diseases at the University of Virginia and the University of Minnesota. He has lived in Halifax since 1985 where he is the Director of the Canadian Center for Vaccinology. He recently held one of two Canadian Institutes of Health Research/Wyeth Pharmaceuticals Clinical Research Chairs in Vaccines. His research focuses on the diagnosis, treatment and prevention of pertussis and other vaccine preventable diseases



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### **Dr Thomas Clark MD, MPH**

Dr Clark grew up in Spokane, Washington. He attended Tulane University in New Orleans, where he obtained both his Bachelors Degree and Medical Degree. After training as a paediatrician at Emory University in Atlanta, he completed training in preventive medicine and public health at Oregon Health Sciences University in Portland, Oregon. He has worked at the Centers for Disease Control and Prevention for 10 years, including 2 years as an Epidemic Intelligence Service Officer. He currently serves as epidemiology team leader in the Meningitis and Vaccine Preventable Diseases Branch, working on meningitis, pertussis, and other bacterial vaccine preventable diseases domestically and globally. He has published over 35 peer-reviewed and scientific papers and book chapters.

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### **Dr Camille Locht**

Camille Locht currently holds a position as Research Director at the French National Institute of Health and Medical Research (Inserm) and heads the Center for Infection and Immunity of Lille on the campus of the Institut Pasteur de Lille in France. He obtained his PhD at the Catholic University of Leuven in Belgium in 1984. After a 3-year post-doctoral stay at the National Institute of Allergy and Infectious Disease in the USA, where he started to work on pertussis and cloned the pertussis toxin genes, he joined SmithKline–Beecham (now GSK) to help developing acellular pertussis vaccines. Since 1989 he is the head of a research laboratory at the Institut Pasteur de Lille, where he is now the Scientific Director. His research interest is in molecular pathogenesis of respiratory infections, essentially pertussis and tuberculosis, with the long-term aim to develop new vaccines against both diseases. He has authored close to 250 international publications, several dozens of patents and has obtained several research awards in France.



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### **Dr Kathleen Harriman**

Dr Harriman is Chief of the Vaccine Preventable Disease Epidemiology Section in the Immunization Branch of the California Department of Public Health. While in this position, she has worked on measles and other vaccine preventable disease outbreaks as well as being heavily involved with the 2009 H1N1 influenza pandemic response and the 2010 pertussis epidemic. Prior to working in California, she worked for 15 years at the Minnesota Department of Health. During her career there she worked in many infectious disease areas, including supervising the Infection Control Unit. Earlier in her career, she worked as a paediatric emergency room nurse and also as an infection preventionist at Minneapolis Children's Hospital. Dr Harriman has an MPH from the University of Sydney and a PhD in Environmental Health (Infectious Disease) from the University of Minnesota.

## Patricia Campbell

Trish completed her Bachelor of Science (Hons) in 2009, majoring in mathematics and environmental studies. She commenced as a research PhD student with the Vaccine and Immunisation Research Group at the Melbourne School of Population Health in early 2010 to develop mathematical models of pertussis transmission. This research project aims to determine the optimal scheduling of pertussis vaccination in Australia to prevent transmission to vulnerable infants who are too young to be immunised.



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## A/Prof Stephen Lambert

Associate Professor Stephen Lambert is a public health physician with a research interest in the epidemiology of vaccine preventable and other communicable diseases. He is a Research Fellow at the Queensland Children's Medical Research Institute working on a community-based birth cohort study of respiratory and gastrointestinal viral infections in the first 2 years of life, and at the Queensland Health Immunisation Program supporting analysis and research around the impact of vaccines.



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## A/Prof Ruiting Lan

Ruiting Lan is currently an associate professor of Medical Microbiology at the University of New South Wales. Ruiting obtained his PhD from the University of Sydney and did his postdoctoral training in Prof Peter Reeves' laboratory also at the University of Sydney. Ruiting works on a number of bacterial pathogens with the primary focus on population biology, evolution and molecular epidemiology. His current research on *Bordetella pertussis* is aiming to understand strain variation and resurgence of pertussis in Australia.



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## A/Prof Helen Marshall MBBS MD MPH DCH

Associate Professor Helen Marshall is the Director of the Vaccinology and Immunology Research Trials Unit (VIRTU) at the Women's and Children's Hospital and Associate Professor in Vaccinology in the School of Paediatrics and Reproductive Health at the University of Adelaide. Associate Professor Marshall is a medical graduate of the University of Adelaide who has completed a Master in Public Health degree (University of Adelaide) and the Advanced Vaccinology Course at the Pasteur Merieux Institute, France. She was recently awarded a Doctorate of Medicine from the University of Adelaide, an NHMRC Career Development Fellowship and the South Australia Science Award for Excellence in Research for the Public Good.



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## A/Prof Kristine Macartney

Associate Professor Kristine Macartney is a paediatrician specialising in infectious diseases. She is a medical graduate of the University of New South Wales and undertook her specialty training in Sydney and in the United States at the Children's Hospital of Philadelphia. Her Doctorate of Medicine was on rotavirus infection, in particular the mucosal immune response to novel vaccine candidates. She was a founding member of the Vaccine Education Center at the Children's Hospital of Philadelphia, and is currently Deputy Director of Government Programs at the National Centre for Immunisation Research and Surveillance (NCIRS) and a paediatric infectious diseases consultant at The Children's Hospital at Westmead. Her research interests include translation of evidence into policy and practice, vaccine safety, and most other areas of vaccine preventable diseases research, particularly in relation to rotavirus, varicella-zoster virus and influenza. She was a co-editor of *The Australian Immunisation Handbook* (9<sup>th</sup> edition, 2008) and has authored many peer-reviewed publications. She is a member of the Advisory Committee on the Safety of Medicines (ACSOM) of the TGA.



### **Prof Peter McIntyre**

Peter McIntyre is Director of the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS), and a Senior Staff Specialist in Infectious Diseases at the Children's Hospital at Westmead. His major interests are in the epidemiology of vaccine preventable diseases, particularly invasive *Haemophilus influenzae* type b (Hib), pneumococcal disease and pertussis. In Australia, he is a member of the Australian Technical Advisory Group on Immunisation (ATAGI), the Communicable Diseases Network of Australia (CDNA), and the National Immunisation Committee (NIC). Internationally, he is a member of Working Groups for the WHO Strategic Advisory Group of Experts on Pertussis and Pneumococcal Vaccines and an invited speaker at international meetings on pertussis and neonatal immunisation. Peter McIntyre is a reviewer for over 10 national and international journals and the author of over 150 papers and book chapters.



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### **A/Prof Jodie McVernon**

Jodie McVernon is a Monash University Medical Graduate with subspecialty training in Paediatrics, Public Health and Vaccinology. She has extensive expertise in clinical vaccine trials, epidemiologic studies and mathematical modelling of infectious diseases, gained at the University of Oxford, Health Protection Agency London and University of Melbourne. She has a particular interest in key drivers of infection spread in populations, and the likely impact of public health interventions to reduce transmission.



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### **Dr Anthony Newall**

Dr Anthony Newall is a lecturer in health economics at the School of Public Health and Community Medicine, University of New South Wales. He is also an honorary fellow at the National Centre for Immunisation Research and Surveillance. He completed his Masters of Public Health (Hons) and PhD at the University of Sydney. His research focus is the epidemiology and economic evaluation of vaccine preventable diseases. He has published work on the epidemiology and cost-effectiveness of prevention strategies for rotavirus, influenza (seasonal and pandemic), and human papillomavirus. He was awarded the Young Investigator of the Year (2008) by his research school based on evidence of significant research impact in public health. He has been a visiting scholar at the US National Institutes of Health (NIH) in Bethesda, Maryland. He is currently working on the evaluation of influenza vaccination strategies as part of his NHMRC Public Health Training Fellowship.



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### **Dr Helen Quinn**

Helen is a research fellow at the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS) and has a conjoint academic appointment as Lecturer in the Discipline of Paediatrics and Child Health and the School of Public Health at the University of Sydney. Her background is in laboratory science (PhD in parasitology), with further training as an epidemiologist. Helen's main interest is the epidemiology and control of vaccine preventable diseases, particularly pertussis. She is also interested in immunisation policy and attitudes to immunisation in parents and providers.



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### **Dr Nicholas Wood**

Dr Nicholas Wood is a staff specialist in general paediatrics and immunisation at The Children's Hospital at Westmead and the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS). He has an NHMRC fellowship to examine maternal and neonatal vaccination. He is currently an investigator on a multicentre trial examining newborn responses to acellular pertussis vaccination.



## ABSTRACTS

### **Is Australia the world capital of pertussis?**

*Peter McIntyre*

National Centre for Immunisation Research and Surveillance

Yes, Australia is the world capital of pertussis if the most common means of measuring pertussis, statutory notifications to public health authorities, is considered. In 2009, there were about 106,000 cases of pertussis notified worldwide, with almost 30,000 (28%) from Australia, more than double the number notified to WHO from any other country. Looking more deeply, we find a more complex story, both for Australia and other comparable countries.

The factors impacting on the true underlying incidence and measurement of pertussis are complex, inter-related and include the following:

1. diagnostic awareness – this is especially an issue for less classical presentations of pertussis such as occur in individuals with partial immunity through age and/or immunisation
2. diagnostic tests – these need to be available to be ordered by aware physicians and to have acceptable sensitivity and specificity
3. reporting – this is more likely to occur from laboratories for positive tests than from clinicians, even with classic symptoms
4. vaccines, vaccine coverage and vaccine schedule – vaccine efficacy was shown to vary widely among whole cell vaccines in the 1980s, vaccine coverage was greatly influenced by perceived reactogenicity of pertussis vaccines and duration of immunity is affected by vaccine type and circulation of pertussis in the community. Acellular vaccines, especially when boosting is delayed (as it was in Australia with the cessation of the 18-month booster) are probably especially associated with waning immunity.
5. epidemics which influence both awareness and testing
6. age group – the performance of diagnostic tests and the pattern of vaccine exposure both vary significantly by age.

In Australia, there have been a series of changes in all the above from introduction of mandatory laboratory reporting in the early 1990s, to the availability and promotion of single titre serology in the mid to late 1990s, to the availability of PCR diagnosis first in hospital and then in community practice during the last decade. Different age groups have been affected – adult notifications by serologic testing (from the late 1990s) and notifications of young children by PCR testing (since mid 2000s).

Pertussis reporting also varies by disease severity, with less variation likely in diagnosis of hospitalised cases, although this is also impacted by test availability, especially PCR given the relative insensitivity of culture. Hospitalisations and deaths coded as pertussis are likely to be less subject to reporting deficiencies of clinicians but are impacted on by diagnostic tests. Comparison of notifications, hospitalisations and deaths in Australia shows that the latter two measures of severe disease have varied much less over time than notifications.

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### **Pertussis control – does Canada have it right?**

*Scott Halperin*

Pediatric Infectious Diseases, Dalhousie University, IWK Health Centre, Canada

Vaccines against pertussis have been available and in widespread use for over 60 years. In areas where effective pertussis vaccines (whole cell or acellular) have been widely used, control of pertussis has been achieved in vaccinated cohorts. However, *Bordetella pertussis* continues to circulate and rates of disease have increased in unimmunised populations and in individuals whose vaccine- (or disease-) related immunity has waned. Some jurisdictions have modified their recommendations for pertussis vaccine use to include additional cohorts such as adolescents, adults, postpartum women and, most recently, pregnant women. However, effective pertussis vaccination programs require high rates of vaccine uptake which have not been uniformly achieved beyond the paediatric population. In Canada, publicly funded pertussis vaccination programs exist for children, adolescents and, in some jurisdictions, adults. However, the disconnect between policy and practice still limits the effectiveness of these programs. Strategies are required to ensure that recommendations lead to policies that are effectively implemented to achieve pertussis control objectives. Although Canada is traveling along the correct path, it has a way to go before 'getting it right.

## **An overview of the 2010 California pertussis epidemic and risk factors for fatal pertussis**

*Kathleen Harriman*

California Department of Public Health, USA

In 2010, California, a US state with over 37 million people, experienced a pertussis epidemic with over 9,000 cases, including 10 infant deaths. This represented the most cases since 1947 and the highest incidence since 1958. The prior peak year was 2005 when over 3,000 cases were reported, including 8 infant deaths.

The primary goal of mitigation activities was to prevent infant deaths. Efforts were made to educate clinicians to recognise early disease in infants and hospitalise young infants with pertussis. Recommendations were also provided for the clinical care of severely ill infants, including exchange transfusion. In addition, the California Department of Public Health issued expanded recommendations on the use of Tdap, widely publicised the cocooning strategy and provided free Tdap to hospitals to vaccinate new mothers and other infant contacts.

A risk factor study was initiated to study the 51 reported pertussis deaths in California since 1998 and examine risk factors potentially associated with fatal outcome. All fatal cases were <4 months of age and 80% were Hispanic (approximately 50% of the birth cohort in California is Hispanic). Fatal cases were matched to non-fatal hospitalised cases <4 months of age from the same year and county of residence. Cases were reviewed to assess demographics, underlying conditions, clinical signs and symptoms, time to presentation for care, and course of treatment.

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## **Predictors of severe disease in children hospitalised with pertussis infection during an epidemic**

*Helen Marshall*

Vaccinology and Immunology Research Trials Unit (VIRTU), Women's and Children's Health Network, Adelaide

Despite high immunisation coverage, Australia is experiencing its worst pertussis epidemic since introduction of pertussis vaccine into the national immunisation program. The severity of pertussis infection in hospitalised children has been assessed over a 12-month epidemic period (1 May 2009 – 30 April 2010) with 134 children aged between 10 days and 17 years enrolled from all mainland Australian states. A pertussis severity scoring system (PSS [range 1–18]) was used to identify mild and severe hospitalised cases and determine risk factors associated with severe disease. In hospitalised cases, 61.2% were classified as mild (score <7) and 38.8% as severe (score ≥7). Co-infection, age <2 months and lymphocytosis >20,000 were identified as risk factors for severe hospitalised pertussis and episodes of bradycardia, post-tussive vomiting and any respiratory distress were associated with more severe disease. Rhinovirus and respiratory syncytial virus were the commonest co-infective agents. The majority (73%) of children aged <1 year at the time of admission, had received no prior pertussis immunisation. Transmission of infection most commonly occurred from infected siblings and parents, although transmission from hospital staff and nosocomial infection were also reported. Pertussis remains a poorly controlled vaccine preventable disease associated with significant morbidity. A universal objective scoring system can be used to assess the impact of pertussis, identify risk factors for severe disease, and monitor severe pertussis during epidemic and inter-epidemic periods.

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## **What do we know about source of infant infection?**

*Kristine Macartney*

National Centre for Immunisation Research and Surveillance

Young infants have the highest rates of morbidity and mortality from pertussis. Strategies to protect young infants from acquiring this severe illness have been underpinned by an evolving understanding of the sources of infant infection. Systematic review of the literature reveals 12 original observational studies that aimed to examine the source of infection in infant disease. These studies differed substantially in the use of methods to identify cases and contacts, study size, setting, and the potential for bias. The highest quality studies performed laboratory testing on all infant contacts, including asymptomatic contacts. The proportion of infant cases where a source of infection could not be identified was high, ranging from 30% to 76%.

Overall, mothers were identified as the most frequent source of infection; however, this varied on the setting, with siblings also ranking high as source contacts in a number of studies. Mothers were more likely to be the source of infection for younger infants. Up to 16% of contacts of infant cases had asymptomatic infection. Data on the potential for transmission of infection from non-coughing individuals, and from immunised compared with unimmunised contacts, are sparse and should be the subject of future studies.

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### **Strain variation of *Bordetella pertussis* in Australia: vaccine-driven evolution?**

*Ruiting Lan*

School of Biotechnology and Biomolecular Sciences, University of New South Wales

Despite high pertussis vaccine coverage, pertussis incidence has increased substantially in recent years in many countries including Australia. A significant factor that may be contributing to this increase is adaptation to the acellular vaccine (ACV) by *Bordetella pertussis*, the causative agent of pertussis. Many studies have shown that *B. pertussis* populations have changed after the introduction of vaccination. This talk will present evidence of changes in Australian *B. pertussis* populations and possible effect of the selection pressure from ACV induced immunity.

*B. pertussis* is a highly homogenous pathogen with very low levels of variation between strains. Most changes observed are single base changes referred to as single nucleotide polymorphisms (SNPs). We used SNPs to classify a collection of Australian isolates over a 40-year period. Strains carrying antigen gene alleles different from the ACV were found to belong to two phylogenetic clusters which increased in frequency since the introduction of the ACV, suggesting vaccine driven selection.

We also analysed the variation in the genes encoding the ACV antigens, *prn*, *ptxA*, *fha*, *fim2* and *fim3*. We found that the recently emerged cluster I isolates mostly carry the non-vaccine *prn2* allele and significantly increased in frequency since the introduction of ACV. These results suggest that cluster I emerged and expanded as more fit variant under the selection pressure of the ACV with the potential to evade vaccine induced immunity and to cause more severe disease. These findings have significant implications for control of pertussis and vaccination strategies.

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### **Correlates of protection from pertussis vaccines – one, many or none?**

*Peter McIntyre*

National Centre for Immunisation Research and Surveillance

Although pertussis-containing vaccines have been in wide use for over 50 years, efficacy data are scant. Randomised trials of a whole cell vaccine were conducted in the United Kingdom in the 1950s and then a group of efficacy trials comparing different whole cell with candidate acellular vaccines in Italy and Sweden in the 1980s. The key finding from these latter trials was wide variations in efficacy of whole cell vaccines from around 40% to higher than the best acellular vaccines.

Measurement of the outcome of interest bedevils studies of vaccine impact in pertussis. Even in the clinical trial setting, the question “what is pertussis?” has varied answers from so-called WHO-defined pertussis to any cough illness with microbiologic confirmation. Microbiologic confirmation varies both by time since symptom onset and by diagnostic test. For the former, ascertainment even in a clinical trial setting varies widely from active regular contact to relying on notification to the study team. For the latter, PCR-based diagnosis is much more sensitive than culture and both are more specific than serologic tests but PCR was largely unavailable in the 1980s trials. With respect to serologic correlates, the most helpful clinical studies are case control studies among household contacts of a confirmed case in households which include a child who participated in a vaccine trial – these were reported from both Germany and Sweden with somewhat differing results. The importance of various serologic markers (pertussis toxin, pertactin, FHA and fimbriae) in determining the likelihood of symptomatic pertussis infection following household contact has varied for individual antigens but highest susceptibility among those with no detectable serologic markers post immunisation is a consistent finding. This may suggest genetic factors determining host susceptibility are at least as important as any variations in *B. pertussis* over time.

## **Vaccine effectiveness and duration of immunity, the US experience**

*Thomas Clark*

Centers for Disease Control and Prevention, USA

Following introduction and widespread use of whole-cell pertussis vaccines in the 1940s, reported cases of pertussis in the USA declined from over 250,000 per year to a nadir of 1,010 in 1976. Since then, case reports have increased steadily. Cyclic patterns continue to be observed, with peaks occurring every 3 to 4 years. Over 25,000 cases were reported each year in 2004 and 2005, and final 2010 cases may exceed case counts from those years. High vaccination coverage is observed, with receipt of three or more doses observed among 95% of children aged 19 through 35 months, and 85% receiving four or more doses.

The current US vaccination schedule includes doses of acellular pertussis-containing vaccines at 2, 4, and 6 months with booster doses at age 15–18 months and 4–6 years. Acellular vaccines were recommended for the booster doses beginning in 1992, and in 1997 acellular vaccines were recommended for the entire series. In 2005, recommendations for an adolescent and reduced-dose acellular pertussis vaccine were published, with a single dose preferred at 11–12 years of age. In 2009, Tdap coverage reached 56% among persons aged 13–17 years. Two field studies suggest a short-term effectiveness of Tdap of 65 to 75%, though duration of protection is not yet known. Following the emergence of disease in adolescents observed in the late 1990s and early 2000s, the burden of pertussis in this age group has declined recently, suggesting an impact of the US adolescent Tdap program.

More concerning is the increase in incidence recently observed among children aged 7–10 years. Estimates obtained from a case-control study conducted in 2010 in California suggest that short-term DTaP effectiveness (94.5% within 12 months of receipt) in children aged 4–10 years is comparable to previously published estimates of DTaP effectiveness. However, modest waning of immunity is observed, with 69.1% effectiveness 60 or more months after receipt.

In an analysis of pertussis cases occurring among fully vaccinated children aged 4–10 years in Minnesota, the relative risk of pertussis 5 years versus 1 year after the 5<sup>th</sup> dose was 4. The decline of vaccine effectiveness observed in California is predictive of the relative risk of disease observed in Minnesota, suggesting that the duration of protection of acellular vaccines may be lower than that of whole cell vaccines, accounting for the emergence of disease among young school-aged children. Additionally, studies and analyses are ongoing to assess the impact of waning of immunity on pertussis prevention and control.

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## **Pertussis vaccine effectiveness in Australia**

*Helen Quinn*

National Centre for Immunisation Research and Surveillance

The large increase in notifications of pertussis in Australian children <5 years of age during 2008–2010, in contrast to very low rates in the preceding years, raised the question of decreased vaccine effectiveness (VE). In particular, the discontinuation of the 18-month booster and the impact of this on notifications was of concern. To evaluate this, we used both the screening method and a case control study approach using data on immunisation coverage at the population and individual level from the Australian Childhood Immunisation Register (ACIR). The screening method to estimate VE relies on knowing the immunisation status of cases and population coverage in the relevant age group. For earlier data this was the only practical method. For children who were eligible to receive an 18-month booster dose of DTPa, VE was 88.5% (95% CI: 86.3–90.4%) which was significantly higher than the estimate for children not eligible for this dose (81.6% [95% CI: 79.7–83.3%]). The lowest estimate was in 3-year olds and estimates for the 2009 epidemic were lower than those for the most recent epidemic in 2001. Our analysis also showed that VE estimates were lower for children who received DTPa vaccines for their primary series, compared with those who received DTPw. We also used a case control approach by individually matching cases to de-identified children with similar dates of birth on the ACIR. Using this approach, VE estimates for hospitalisation due to pertussis were higher than for non-hospitalised cases in the <1 year age group.

For infants <6 months of age, both hospitalised and not hospitalised, 2 doses of vaccine had higher VE than one dose. In children aged 1 to 3 years, the three-dose VE estimate decreased with age, so that by 3 years, the VE against notified pertussis was 59.0% (95% CI: 46.1–68.9%).

Both methodologies found VE in the expected range within 2 years of receipt of the last primary dose. There was evidence of decreased VE estimates in children older than 2 years, consistent with waning immunity prior to the pre-school booster dose of DTPa scheduled at 4 years of age.

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## **What do we know about the impact of vaccines on transmission?**

*Patricia Campbell*

Melbourne School of Population Health

Transmission is generally defined as the successful transfer of a pathogen between an infectious source and a susceptible host. This process is subject to a range of regulatory factors including vaccination, antibiotic use, immunity and the level of contact between the two individuals. For pertussis, the consequences of transmission may be either detrimental (disease) or beneficial (boosting of immunity without disease).

Direct protective effects of vaccination include reduction in susceptibility, reduction in infectiousness of vaccine breakthrough cases and reduction in progression to disease. It had been suggested that pertussis vaccines offer better protection against disease than against infection, due to the apparently unchanged inter-epidemic period following the introduction of mass vaccination. Conversely, the reduction of case rates in unvaccinated infants, an indirect effect of vaccination, provides much stronger evidence that pertussis vaccines interrupt transmission.

By reducing the circulation of *Bordetella pertussis* in the population, vaccination has impacted both the detrimental and beneficial aspects of transmission. With fewer opportunities for natural boosting, the duration of protection following natural infection or vaccination may be reduced, leading to faster growth of the susceptible pool. Understanding the long-term impact of vaccination on transmission requires the integration of all of these dynamic effects.

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## **Pertussis vaccine schedules – what can serosurveillance and modelling tell us?**

*Jodie McVernon*

Vaccine and Immunisation Research Group, University of Melbourne

Pertussis vaccines exert effects in populations through both direct and indirect (herd immunity) mechanisms. Direct vaccine protection against severe disease has been observed in Australia, with trends in age-specific pertussis hospitalisations reflecting changes to the National Immunisation Program schedule. Assessment of herd effects is more difficult, with increased reports of severe infant disease often considered indicative of declining population protection, but evidenced only 'after the event'.

Sequential serosurveys of pertussis toxin antibody were conducted in the Australian population between 1997 and 2007. These collections demonstrate marked variation in the distribution of antibody concentrations over the period, in clear temporal association with trends in the epidemic cycle and, to a lesser extent, schedule change. Of particular note, a marked increase in the percentage of the population without detectable antibodies preceded onset of a sustained national outbreak that commenced in 2008 and is ongoing.

We will consider the way in which serosurvey data may be incorporated in dynamic transmission models to better understand unobserved shifts in immunity and infection that underpin and potentially predict population experience of disease. Inferences drawn from such data can further inform more robust estimates of vaccine effect with which to consider the impact of alternative immunisation schedules.

## **The use of the cocooning strategy during the 2010 California pertussis epidemic**

*Kathleen Harriman*

California Department of Public Health, USA

The US Advisory Committee on Immunization Practices (ACIP) has recommended Tdap vaccination before pregnancy or in the immediate postpartum period since 2006, the year after Tdap vaccine was licensed in the USA. This is part of a 'cocooning' strategy, which aims to protect young infants from becoming infected with pertussis by vaccinating the people who will be in close contact with them to reduce their chance of becoming infected with and transmitting pertussis to young infants.

During the 2010 pertussis epidemic in California, the cocooning strategy was strongly recommended and widely publicised. The California Department of Public Health issued expanded recommendations for the use of Tdap to facilitate cocooning and also provided free Tdap vaccine to hospitals to vaccinate new mothers and other infant contacts.

A hospital survey conducted at the beginning of the 2010 pertussis epidemic indicated that only 25% of California birth hospitals were offering Tdap to postpartum women as recommended by ACIP and identified reimbursement as a barrier. Infants born in 2009 in hospitals with a postpartum Tdap vaccination policy were less likely to be diagnosed with pertussis. When free Tdap vaccine was temporarily made available to California hospitals in 2010, ~60% of birth hospitals requested vaccine. A follow-up survey evaluating hospital Tdap vaccination practices for postpartum women, other infant contacts and hospital employees was conducted in August 2011.

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## **Experience with cocoon implementation and impact, the US experience**

*Thomas Clark*

Centers for Disease Control and Prevention, USA

In each decade since the 1980s, the number of deaths from pertussis among infants <1 year of age has increased, with 61 deaths reported in the 1980s, 93 in the 1990s, and 201 in the first decade of the 2000s. More than 75% of deaths occur in children too young to receive their first scheduled DTaP dose, and more than 90% before they have completed their primary series. Since licensure of Tdap in 2005, cocooning, or vaccination of close contacts of infants in order to reduce transmission, has been the recommended strategy in the USA to prevent morbidity and mortality from pertussis in the youngest infants. Successful examples of cocooning have been observed in individual hospitals and at least one US state has established a cocooning program in all birthing hospitals. Successful programs are characterised by the presence of a 'champion' who leads efforts to establish and maintain the program, and often rely on donated vaccine and provider time. High coverage among post-partum mothers has been achieved in some demonstration projects, but institutional barriers to vaccinating mothers exist, including 'bundling' of labour and delivery services with an inability to incorporate additional services or change the insurance payment for additional services. Further barriers have limited the success of vaccinating fathers and other caregivers, substantially limiting coverage in these groups. Barriers include inability to register other persons as patients and provide care, and loss to follow-up when referrals are made for vaccination. The presence of certain 'success factors' alone is not sufficient to ensure a successful program, and other examples exist of programs achieving poor coverage even with the provision of vaccine at no cost. No observational data exist as to the effectiveness of cocooning, and ecologic studies of the impact of maternal postpartum vaccination find mixed results. The challenges to implementing cocooning make it unlikely to substantially reduce infant pertussis morbidity and mortality. A decision analysis model suggested that a fully implemented program of post-partum vaccination might reduce cases, hospitalisations and deaths by 33%, 38% and 49%, respectively, compared to 20%, 18%, and 16% reductions, respectively, for post-partum maternal vaccination alone. The improved prevention would be achieved at the same cost. At its most recent meeting, the Advisory Committee on Immunization Practices (ACIP) approved a recommendation for Tdap vaccination during pregnancy. ACIP continues to recommend vaccination of close contacts of infants. A multi-state study is being implemented to evaluate the effectiveness of both cocooning and pregnancy vaccination on preventing pertussis in infants.

## **Experience with cocoon implementation and impact: Australia**

*Stephen Lambert*

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Queensland Children's Health Services and Queensland Health Immunisation Program

Australia has had a large and persisting nationwide outbreak of pertussis since 2009. Associated with this outbreak have been a number of highly publicised infant deaths, where cases were too young to have started or completed the full primary course of three doses of acellular pertussis-containing vaccine. In response to this, cocoon strategies, targeting new parents, but in some cases extended to other household members or adults with regular contact with an infant, such as carers or grandparents, for adult pertussis vaccination were implemented.

We sought information from State and Territory Health Departments about cocoon strategy implementation in their jurisdiction. Details of research to formally assess vaccine effectiveness were also summarised.

All States and Territories implemented a cocoon strategy in some form, although timing and the scope of the programs varied. Stop dates for most programs have been extended a number of times, based on the continuing high number of notified pertussis cases.

Formal vaccine effectiveness studies, using a case-control method, are planned in New South Wales and Queensland. Both studies have elements in common, including the possibility there will be insufficient power to identify a modest effectiveness value, and difficulties and delays in negotiating a process for contacting control subjects.

Cocoon strategies were implemented in all States and Territories in the context of a large and continuing increase in nationwide pertussis notifications from 2009. Local cocoon vaccine effectiveness studies may help inform future plans for this strategy.

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## **The cost-effectiveness of pertussis vaccination strategies**

*Dr Anthony T Newall*

The School of Public Health and Community Medicine (SPHCM), University of New South Wales. In recent years several cost-effectiveness analyses of pertussis vaccination have been published. The economics of pertussis vaccination is complicated by several factors, including the unreported disease burden and herd immunity effects, as well as the existence of multiple non-independent strategies, where the implementation of any one strategy impacts the costs and health effects of the alternatives. In addition to infant vaccination, various potential strategies have been evaluated; these include parental cocooning, maternal, infant at birth, pre-school, adolescent and adult vaccination. Several recent publications have attempted to evaluate the relative cost-effectiveness of multiple strategies, with some incorporating dynamic transmission models able to capture the herd protection conferred by vaccination to the wider population. However, uncertainty remains over the relative cost-effectiveness of alternative strategies and the most effective way to protect the population at a reasonable cost. The cost-effectiveness results from recently published studies will be presented and the key drivers in the economic models will be identified. The implications of the results from these studies and directions for future cost-effectiveness research will be discussed.

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## **Maternal immunisation – can we do it, what can we expect?**

*Scott Halperin*

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Although pertussis has been well controlled through vaccination in older infants and children, substantial morbidity and occasional mortality persists in young infants under 6 months of age. Various strategies to address this disease burden have been proposed including 'cocooning' and neonatal vaccination. Immunising women in the latter part of pregnancy has the potential to provide protection through transplacental transfer of antibodies to the fetus and through postpartum antibodies in breast milk. Potential problems with this strategy are concerns about the safety of pertussis vaccine during pregnancy and interference with the response to the active infant series as a result of high levels of passive antibody.

Two randomised clinical trials are examining the safety of adult formulation tetanus-diphtheria-acellular pertussis vaccine (Tdap) during pregnancy; interim analysis of one study demonstrates that the vaccine is well-tolerated during pregnancy, high levels of pertussis antibodies are achieved in the newborns, and that some interference with the active antibody response to DTaP in the infants is observed. Recently, the United States Advisory Committee on Immunization Practices has recommended that all pregnant women receive a dose of Tdap during the second half of pregnancy. Examination of the final results of the two randomised controlled trials and careful evaluation of the effectiveness of the new ACIP recommendations is essential.

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### **Neonatal immunisation – can we do it, what can we expect?**

*Nick Wood*

National Centre for Immunisation Research and Surveillance

Recognition of the high burden of disease in early life and advances in the understanding of neonatal immunology has resulted in renewed interest in maternal and neonatal vaccination. New vaccine strategies are particularly important for prevention of pertussis, where the youngest infants have the highest morbidity and mortality and are unable to be protected by current vaccination schedules.

Recent neonatal acellular pertussis (Pa) vaccine trials have proven well tolerated and immunogenic, identifying vaccine interference as a critical issue to address. In three studies where newborns were primed with Pa vaccine, earlier pertussis antibody responses were achieved compared to infants who commenced pertussis vaccination at 2 months and no immune tolerance was seen at follow-up. Pertussis-specific Th-memory cells elicited at birth displayed a strong Th2 bias with higher IL-5 and IL-13 responses; however, this was not associated with increased adverse events nor extended to simultaneously administered antigens. Hurdles to neonatal vaccination include safety concerns, both immunological and clinical, demonstration of vaccine efficacy, especially in the absence of immune correlates that equate with protection or that are confounded by the presence of maternal antibodies, and public acceptance – reflected by the difficulties in recruiting for neonatal vaccine studies.

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### **Towards a live attenuated nasal vaccine to control pertussis**

*Camille Locht*

Center for Infection and Immunity of Lille, Institut Pasteur de Lille, France

To solve the problem of infant pertussis, early vaccination, preferably at birth, has a number of advantages, but is hampered by the neonatal immaturity of the immune system. Nevertheless, natural infection with *Bordetella pertussis* induces strong responses in very young infants. Therefore, we developed BPZE1, a live attenuated nasal vaccine, by the genetic inactivation or elimination of three toxins. BPZE1 was found to be safe in pre-clinical models, including in immunodeficient animals, such as IFN-gR KO, SCID and MyD88 KO mice. However, a single nasal BPZE1 administration induced strong anti-*Bordetella* B and Th1 T cell responses and long-lasting ( $\geq 1$  year) protection in infant mice. Protection was very rapid and detectable within days after immunisation. BPZE1 also protected against *Bordetella parapertussis* and *Bordetella bronchiseptica*. As a bonus, BPZE1 displayed potent anti-inflammatory activity and protected mice against lethal influenza virus infection and against experimental allergic asthma.

The vaccine strain is now undergoing phase I safety trials in humans. A dose-escalating ( $10^3$ ,  $10^5$  and  $10^7$  cfu), placebo-controlled, double-blind, first-in-man safety trial was started on September 9<sup>th</sup>, 2010. The vaccines have been followed for 6 months, and the safety and preliminary immunogenicity data are expected by the end of 2011.

**The epidemiology of pertussis in Queensland: contribution of laboratory testing to the current outbreak**

*Stephen Lambert,<sup>1,2</sup> Christine Selvey,<sup>2</sup> Cheryl Bletchly,<sup>3</sup> Graeme Nimmo<sup>3</sup>*

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Introduction: Since 2009 there has been a dramatic increase in national pertussis notifications. The contribution of laboratory testing changes, specifically PCR usage, has not been well characterised.

Methods: We calculated Queensland age-group specific notification rates and examined changes in laboratory test type. We used Queensland Health laboratory data to monitor changes in testing behaviour and the emergence of PCR testing in recent years.

Results: Annual pertussis notification rates in Queensland increased from 53 per 100,000 in 2008, to 140 per 100,000 in 2009, and 185 per 100,000 in 2010. Whilst increases were seen in all age groups, they were greatest in those aged 5 to 19 years, peaking for 9-year olds in 2010 at 396 per 100,000. The proportion of all notifications PCR-confirmed was 24% in 2009 and 32% in 2010. Using Queensland Health testing data, the mean annual number of pertussis tests of any type performed between 2004 and 2008 was 3,201, with 40–45% of these PCR. In 2009, this increased to 7,079 (54% PCR), and 8,677 in 2010 (64% PCR). The monthly proportion of all tests positive in 2009 and 2010 (PCR and serology) remained between 5% and 15%, a range similar to that seen in previous non-epidemic periods.

Discussion: Overall and age-group specific changes in testing, particularly by PCR, may explain some of the recent increase in the identification of pertussis infection. Our interpretation of notification data and what constitutes an outbreak needs to incorporate the introduction of new tests and dramatic changes in testing behaviour.

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**Community awareness and acceptance of recommended vaccination programs to prevent pertussis and transmission of infection**

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Background: Adults are susceptible to pertussis infection due to waning immunity and have been shown to be a source of transmission of infection to infants. The aim of the study was to assess the community awareness and knowledge of pertussis, transmission of infection, household cases of pertussis and awareness of preventative strategies including use of a pertussis booster vaccine for adults.

Methods: A cross-sectional study was conducted by Computer Aided Telephone Interviews in April and May 2011 in rural and metropolitan South Australia. Statistical analyses were performed using data weighted to the South Australian population.

Results: Of 1,967 adults interviewed, 97.1% had previously heard of whooping cough and 19.7% believed whooping cough was extremely contagious. Over half of the participants (60.5%) were aware a vaccine was available to prevent whooping cough in adults. Only 5.4% of the participants reported receiving the booster whooping cough vaccine within the past 12 months with an additional 4.9% having received the vaccine within the last 1 to 5 years. 77.2% of participants said they would be more likely to receive the vaccine if it was provided free. 18.4% of participants reported a household member had previously been diagnosed with pertussis with 9% recalling the infection had occurred in the last 12 months.

Conclusion: Pertussis infection is very common in the South Australian community with almost 1 in 5 households being affected. Despite over half of household participants being aware of the availability of an adult booster vaccine, uptake of the vaccine has been low.

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### **Investigating genome evolution of *Bordetella pertussis* using Reverse Line Blot typing**

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Introduction: Despite widespread vaccination, there has been a re-emergence of *Bordetella pertussis*. Microarray studies have investigated the genetic composition of the organism in order to determine what has contributed to its re-emergence. Regions of difference (RDs) have been identified as clusters of genes flanked by insertion sequences. RDs are potential markers of *B. pertussis* evolution.

Method: Forty-one strains from the pre-Whole Cell Vaccine (WCV), post WCV and acellular vaccine (ACV) eras were screened for RD variation. Forty-three genes representing 30 regions of difference were combined into 5 multiplex PCR. Products were then run on a reverse line blot which was used to determine their absence or presence.

Results: When RDs were mapped against the evolutionary relationships of the strains, the losses of two RDs correspond with significant events in *B. pertussis* history. The loss of BP0910-0934 coincides with the introduction of whole cell vaccines in the 1950s while the loss of the RD containing BP1948-1962 first emerged after the introduction of ACV in various countries. This RD loss also coincides with the expansion of the most recent cluster of epidemic *B. pertussis* strains.

Discussion: Reverse line blotting provided a relatively inexpensive and fast method of determining the gene content of *B. pertussis* strains and can be used as a method of typing of *B. pertussis*. We observed that loss of 2 RDs in isolates correlates with the introduction of widespread vaccination.

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### **Molecular typing of *Bordetella pertussis* implicated in Australian pertussis epidemic in 2008–2010**

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Introduction: Pertussis is a vaccine preventable disease but it has re-emerged as a significant public health threat in populations with high vaccination coverage. The increasing disease rates have been reported in many countries, including Australia. Epidemic cycles occur every 3–5 years in Australia with the latest prolonged epidemic started in 2008. Factors thought to contribute to the resurgence of pertussis include waning immunity; improvements in diagnostic and surveillance systems; and the antigenic divergence of its causative agent, *Bordetella pertussis*, as a result of vaccination.

Methods: In this study, a total of 194 *B. pertussis* isolates collected from four Australian states during 2008–2010 were typed, by single nucleotide polymorphisms (SNPs), multilocus variable number tandem repeats analysis and *fim3*, *prn* and *ptxP* sequence analyses.

Results: Strains with two closely related SNP profiles (SNP profile 13 and 14) from recently emerged SNP cluster I predominated. These SNP profiles carried *prn2* and *ptxP3* alleles.

Discussion: Previous immunological evidence has shown that *prn2* has an advantage against vaccine-induced selection pressure, while *ptxP3* has been found to be associated with higher virulence, based on hospitalisation and case mortality from a study in the Netherlands. Therefore, it appears that there is a selection pressure for *B. pertussis* to carry both *prn2* and *ptxP3* alleles. Monitoring of the *B. pertussis* clones observed in Australia across the globe, particularly in countries covered by the same vaccine formulations used in Australia, is important in the control and prevention of pertussis.

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### **Adolescent pertussis vaccination coverage in Victoria – the role of GPs**

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Introduction: In Victoria, an adolescent dose of Boostrix<sup>®</sup> is provided through local council programs. Reported vaccination coverage declined from 78% to 74% over the past 5 years. Although vaccination coverage appears to be decreasing, it is possible that adolescents are being vaccinated elsewhere. GPs can order Boostrix<sup>®</sup> for the adolescent dose; however, there is no system to collect coverage data. This study aimed to estimate Boostrix<sup>®</sup> coverage provided through general practice among Year 10 students during 2009 in Victoria.

Methods: The study was conducted using a random cluster survey design, targeting GP practices known to have ordered Boostrix<sup>®</sup> for the scheduled adolescent dose. Data were analysed to generate estimates of adolescent Boostrix<sup>®</sup> coverage through general practice. These estimates were combined with those from local councils to calculate an estimate of pertussis vaccination coverage in Victorian Year 10 students during 2009.

Results: Although participation was low (35% of selected GP practices), we calculated that approximately 10% of enrolled year 10 students in Victoria were vaccinated by their GP in 2009. It was estimated that pertussis vaccination coverage in Victoria during 2009 was approximately 80% of enrolled year 10 students.

Discussion: Although this study had several limitations and possible sources of bias, it quantifies the role that GPs play in vaccinating adolescents. However GPs may assume that it is not their role to vaccinate adolescent patients or that they are already vaccinated. Promoting the role of GPs in pertussis vaccination coverage may be of benefit.

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### **Effectiveness of three or four doses of acellular pertussis vaccine in preventing pertussis notification and hospitalisation in Queensland children during 2009**

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Introduction: In response to the recent pertussis epidemic, we assessed the effectiveness of pertussis vaccine in preventing notification and hospitalisation in two specific Queensland birth cohorts during 2009.

Methods: Vaccine effectiveness (VE) values for preventing notification and hospitalisation were calculated using the screening method, with data from the Queensland Notifiable Conditions System and the Queensland Hospital Admitted Patient Data Collection, respectively. Vaccination status of cases was obtained from the Vaccine Information and Vaccine Administration System. Aggregated population coverage figures from the Australian Childhood Immunisation Register were provided by the National Centre for Immunisation Research and Surveillance.

VE of three primary course doses was calculated for a birth cohort aged between 1 and 4 years in 2009. The effectiveness of four doses was calculated for a cohort aged between 5 and 7 years.

Sensitivity analyses on method of diagnosis (combinations of PCR, culture and serology) and hospitalisation coding (principal versus any diagnosis) were performed. Sensitivity analysis using a 4th-dose assumption was performed.

Results: Three-dose VE for preventing notification (PCR or culture) among children aged 1–4 years was 86.0%. Three-dose VE for preventing hospitalisation was 82.2% to 87.7% (any/primary diagnosis) among the same cohort. Four-dose VE for preventing notification among children aged 5–7 years was 59.8% to 67.2% (without/with 4th-dose assumption). Inclusion of serological diagnoses did not substantially alter VE estimates.

Discussion: During 2009, pertussis vaccine provided very good protection for younger children against notification and hospitalisation, and modest protection for older children against notification.

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### **Midwife attitudes: an overlooked determinant of maternal post-partum pertussis booster vaccination completion**

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Introduction: To determine the feasibility of implementing routine dTpa booster vaccination in the maternity ward, the midwife's role was studied. Their support is vital in achieving high vaccine uptake among this target group.

Method: We assessed midwives' attitudes toward pertussis booster vaccination, their perceived susceptibility and severity of pertussis in their patients' communities, the perceived barriers and benefits of their patients' vaccinations, and their cues to action and self-efficacy in vaccination. A self-completed questionnaire, which evaluated constructs of the Health Belief Model and measured demographic information, was completed during in-services at a large public hospital and adjacent private hospital in New South Wales, Australia.

Results: Midwives who thought that it was easier to integrate pertussis booster vaccination were more likely to think that babies could easily catch pertussis ( $p < .05$ ). Midwives who thought it was easier to integrate pertussis booster vaccination were also more likely to have higher perceived self-efficacy in delivering booster vaccination, measured through perceived importance of the vaccination role as part of the job ( $p < .05$ ), perceived confidence in delivering vaccination as part of the role ( $p < .05$ ), and perceived sufficient level of skills to deliver booster vaccination ( $p < .01$ ).

Conclusions: Key factors of postnatal pertussis booster vaccination delivery were the midwives' perceived susceptibility of newborns to pertussis and their own perceived self-efficacy of providing the vaccination. This validates past qualitative research which suggested that disease perception influenced midwives' support of vaccines. Further research needs to explore the degree to which midwives' beliefs about the importance of the vaccine influences how pro-active they are in implementation.

## **An evaluation of the Department of Health 'Boostrix for New Parents' immunisation program in Eastern Melbourne, Victoria**

*W Bissinger*

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**Background:** Boostrix (a vaccine containing pertussis, diphtheria and tetanus antigens) has been available free of charge from general practitioners, local council immunisation sessions and maternity hospitals for new parents for the last 18 months. It is intended as a cocoon strategy for new infants prior to them receiving their own immunisations. This study assesses the penetration of this program into the eligible parent population of Eastern Melbourne, Victoria, Australia.

**Methodology:** Parents presenting to general practice or council immunisation session with their 2-month old infant for the first routine infant immunisation were asked to complete a simple questionnaire. Questions were asked about their knowledge about the 'Boostrix for New Parents' program, whether they or their partner has been immunised with Boostrix vaccine as part of the program and where was the immunisation given. They are offered the vaccine on completion of the questionnaire if not already immunised. Survey lasted 6 weeks.

**Results:** Initial findings indicate reasonable knowledge of the program, adequate uptake in mothers but poor uptake in fathers. New born babies are susceptible to pertussis until they complete their primary immunisation course at 6 months of age.

**Conclusions:** Providing immunisation against pertussis to parents with free boosters and encouraging vaccination in close contacts provides some protection to the infant. Free vaccine programs are only useful if the vaccine is used as intended, in a timely and appropriate fashion – evaluation of such programs gives information about the reach of a program and can influence program and process changes to improve future vaccine delivery.

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## **Pertussis vaccination in child care workers: room for improvement in coverage, policy and practice**

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**Introduction:** The "Staying Healthy in Child Care" Australian guidelines provide for exclusions and encourage vaccination of staff in child care settings; however, these are not enforced through accreditation and licensing processes, and their level of implementation is unknown. This project aimed to: describe pertussis vaccination coverage in child care workers in a regional area of NSW during 2010; review current practices in relation to staff pertussis vaccinations; and determine barriers to vaccination.

**Methods:** A cross sectional survey of all child care centre directors in the Hunter New England (HNE) area of northern NSW was conducted in 2010.

**Results/ Summary of outcomes:** Ninety-eight per cent (319/326) of child care centres identified within the HNE area completed the survey. Thirty-five per cent (113/319) of centres indicated that they had policies concerning respiratory illness in staff members. Sixty-three per cent (202/319) of centres indicated that they kept a record of staff vaccination. However, 74% (125/170) indicated it was only updated if a staff member notified them of vaccinations. Of centres with records, 58% indicated that less than half of their staff were vaccinated.

**Discussion/Conclusion/Recommendation:** Many child care workers have not had a recent pertussis immunisation. This potentially places young children, who are most vulnerable to severe pertussis disease, at risk. With increasing use of child care, national accreditation and licensing requirements are required that monitor the implementation of policies on child care worker vaccination. Higher levels of child care worker vaccination and rigorous policy implementation monitoring will help to reduce the risk of pertussis outbreaks in child care centres.