Table 1

Protein antigen	Research data
Pneumococcal surface protein A (PspA)	Protective aganist multiple pneumococcal serotypes in mice models of invasive disease pneumonia, and colonization. Vaccination of healthy volunteers with PspA generated antibodies aganist multiple strains that protected mice aganist invasive disease. Human studies in progess.
Pneumolysins.Pneumolysoids	Protection aganist Pneuminia and increased survival after intraperitoneal challenge. human studies in progress
Neuraminidases (Nan)	Protection aganist colonization and otitis media
Pneumococcal surface protein C (PspC)	Protection aganist colonization. Protection aganist sepsis
Pneumococcal protective protein A (PppA)	Protection aganist lung infection. Protective aganist nasopharyngeal colonization.
Pneumococcal Histidine Trial Protein D	Protective aganist animal models of invasive disease and pneumonia phase II trial reports awaited.
IC4 antigens	Protection aganist sepsis, pneumonia, nasopharyngeal carriage.

Conclusion: Despite gaps in knowledge, Pneumococcal Protein Vaccines could be an efficacious, effective and economic alternative to currently available Pneumococcal Conjugate Vaccines for the control of pneumococcal infections.

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A survey of maternal pertussis vaccine uptake in England

H. McAuslane[1,*], N. Andrews[2], L. Coole[1], A. Wensley[1]

[1] *Public Health England, Leeds, United Kingdom*
[2] *Public Health England, London, United Kingdom*

Background: In 2012 the UK experienced a national outbreak of pertussis. The highest rates of infections were seen in infants aged less than 3 months and there were 14 deaths in this age group attributable to pertussis. This outbreak prompted the Department of Health (DH) to introduce a temporary vaccination programme for pregnant women with the aim of preventing infections in very young infants.

This survey aimed to estimate pertussis vaccine uptake in pregnant women and describe variations according to age, ethnicity, parity and location. Information was also gathered on influenza vaccine uptake.

Methods & Materials: This was a cross–sectional survey of vaccine uptake among women delivering in maternity units in England over a five-day period during April and May 2013. The target sample size was at least 380 women from maternity units throughout the country. Units were asked to complete surveys alongside birth paperwork for all women delivering a live birth during the 5 day period. Proportions vaccinated were calculated with 95% confidence intervals and multiple logistic regression used to assess differences in uptake.

Results: Twenty–nine trusts participated in the survey, returning 1325 surveys, 85% of which contained information about vaccine uptake. Pertussis vaccine uptake was 52.6% (range 18.1% to 72.4%). Influenza vaccine uptake was 52.2% (range 29.0% to 70.1%). Uptake of both vaccines was significantly higher in the White British ethnic group than in any other at 60% (95% CI 56% - 62%). Women in the most deprived quintile were least likely to have had either vaccine (pertussis vaccine OR v's least deprived 0.44, 95% CI 0.28–0.67/influenza vaccine OR 0.56, 95% CI 0.36–0.86). Ninety–eight per cent of this sample received the pertussis vaccine within the recommended 28–38 weeks gestation timeframe.

Conclusion: The results of this survey indicate that vaccine uptake rates in pregnant women vary significantly across regions and are affected by factors such as ethnicity and deprivation. Every opportunity should be taken to promote both pertussis and influenza vaccines to pregnant women.

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Reduction in vomiting associated with norovirus vaccination in a live norovirus human challenge study

R. Goodwin[1,*], D. Bernstein[2], R.L. Atmar[3], G.M. Lyon[4], J.J. Treanor[5], W.H. Chen[6], R.W. Frenck[2], X. Jiang[2], J. Vinje[7], M.S. Al-Ibrahim[8], J. Barrett[9], D.Y. Graham[10], A. Borkowski[11], R. Clemens[11], P.M. Mendelman[1]

[1] *Takeda Vaccines, Bozeman, USA*
[2] *Cincinnati Children's Hospital Medical Center, University of Cincinnati, Cincinnati, USA*
[3] *Baylor College of Medicine, Houston, TX, USA*
[4] *Emory University School of Medicine, Atlanta, USA*
[5] *University of Rochester Medical Center, Rochester, USA*
[6] *University of Maryland School of Medicine, Baltimore, USA*
[7] *Centers for Disease Control and Prevention, Atlanta, USA*
[8] *Shin Nippon Biomedical Laboratories, Baltimore, USA*
[9] *The EMMES Corporation, Rockville, USA*
[10] *Baylor College of Medicine, Houston, USA*
[11] *Takeda Vaccines, Zurich, Switzerland*

Background: Noroviruses (NoVs) are the leading cause of acute infectious gastroenteritis worldwide and are highly contagious. Although commonly associated with contaminated food and water, the majority of outbreaks reported in the United States are a result of person-to-person transmission. Vomiting may play a critical role in person-to-person transmission. Since environmental contamination resulting from episodes of vomiting have been implicated in norovirus outbreaks, a strategy to reduce norovirus-associated vomiting would have public health benefit.

Methods & Materials: Healthy adult subjects age 18-49 were randomized equally to two study groups to either receive two intramuscular injected doses of an investigational norovirus bivalent GI.1/GII.4 VLP vaccine or saline placebo on study days 1 and 28. On study day 56, 109 subjects were admitted to an in-patient unit and administered an oral dose of 4.4×10^3 PCR units of a live GII.4 norovirus; 56 vaccine recipients and 53 saline placebo recipi-

ents. Symptoms of gastroenteritis, including vomiting and diarrhea, occurring in the in-patient unit were recorded post-challenge.

Results: In the per protocol population, 4/48 (8.3%) of placebo subjects and 0/50 (0%) of vaccine subjects experienced severe vomiting (100% reduction, p = 0.054). 8/48 placebo subjects (16.7%) vs. 1 vaccine subject (2.0%) experienced moderate or severe vomiting (88.0% reduction, p = 0.015), and 17/50 placebo subjects (35.4%) vs. 4/48 vaccine subjects (8.0%) experienced mild, moderate or severe vomiting (77.4% reduction, p = 0.001). Reports of vomiting or diarrhea of any severity were significantly reduced in the vaccine group (10/50, 20%) compared with the placebo group (20/48, 41.7%; p = 0.028), a 52% reduction.

Conclusion: In this study the experimental norovirus vaccine was associated with significant reductions in vomiting. This bivalent norovirus vaccine may provide a means to reduce transmission via aerosolized virus and contaminated fomites as a result of a reduction in vomiting episodes. Field efficacy studies are warranted to further evaluate protection.

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Meningococcal serogroup A and tetanus immunity two years after MenAfriVac™ introduction in Mali

N.E. Basta [1,*], S. Ng [1], A. Berthe [2], X. Bai [3], H. Findlow [3], R. Almond [3], R. Borrow [3], S. Sow [2]

[1] *Princeton University, Princeton, NJ, USA*
[2] *Centre pour les Vaccins en Developpement-Mali, Bamako, Mali*
[3] *Public Health England, Manchester, United Kingdom*

Background: In 2010, a conjugate meningococcal serogroup A (NmA) vaccine (PsA-TT; MenAfriVac™) was introduced in Africa's first-ever preventative meningococcal mass-vaccination campaign. PsA-TT clinical trials indicate that immunity against serogroup A disease persists for at least one year and that vaccination boosts tetanus immunity because tetanus toxoid is used as a carrier protein. Yet, questions remain about long-term antibody persistence against meningococcal serogroup A and the extent of tetanus boosting in the population following introduction.

Methods & Materials: We conducted a cross-sectional household-based age-stratified seroprevalence survey in Banconi, Bamako, Mali in 2012. Randomly selected participants (n = 800) were eligible if they were present in Bamako and aged 1-29 years during the 2010 vaccination campaign and if they were healthy at enrollment. Serum samples were analyzed to determine NmA-specific serum bactericidal antibody (rSBA) titers (reference strain F8238), NmA-specific total IgG using enzyme-linked immunosorbent assay (ELISA), and anti-tetanus toxoid IgG concentrations by florescent bead assay. The relationship between several predictive factors and immunity was also assessed. Lab and questionnaire data were analyzed with STATA v12.1.

Results: All participants were living in Bamako and eligible to receive PsA-TT during the mass-vaccination campaign; 99.5% reported receiving the vaccine. Nearly all participants (99.0%) had NmA-specific SBA titers ≥8, the standard protective threshold; 97.8% had SBA titers ≥128; 89.5% had SBA titers ≥1024. SBA geometric mean titers were higher in females than males except in participants > 18 years of age at vaccination. IgG levels ≥2 μg/mL were found in 88.5% of participants. Forty two percent of participants had anti-tetanus IgG levels less than 1.0 IU/mL, indicating a lack of long-term protection against tetanus. Twelve percent had anti-tetanus IgG levels less than 0.1 IU/mL, indicating no evidence of tetanus immunity (Fig. 1).

Fig. 1 Distribution of anti-tetanus lgG tetors by age and sex based on age at enrollment in December 2012, Two years after the PaA-IT mass vaccination campaign.

Conclusion: Two years after the PsA-TT mass-vaccination campaign, we found evidence of persistent immunity against NmA in Mali. However, there is a lack of evidence that PsA-TT has boosted tetanus immunity, which may be explained by limited exposure to primary tetanus vaccination in this population prior to PsA-TT introduction. Our study highlights the need to go beyond clinical trials and assess long-term vaccine effectiveness post-introduction in representative populations.

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Development of an influenza candidate vaccine using Lactococcus lactis

P.F. Jee [1,*], S. abubakar [1], W.F. Wong [1], R.Abdul Rahim [2], L.Y. Chang [1]

[1] *University of Malaya, Kuala Lumpur, Malaysia*
[2] *Universiti Putra Malaysia, Serdang, Selangor, Malaysia*

Background: *Lactococcus lactis*, a generally recognized as safe (GRAS) bacterium, has become a growing interest in vaccine research due to its non-pathogenic and non-colonizing properties. It is an attractive tool to deliver antigens by mucosal routes, which could eventually elicit protective immunity, both systemic and mucosal immunity. Considering influenza virus is a mucosal pathogen, gaining entry into humans via the mucosal surface, an ideal influenza vaccine that is able to generate both systemic and mucosal immunity is required. The present study aims to develop a candidate vaccine for influenza using *L. lactis* as a vehicle to deliver influenza antigens.

Methods & Materials: In this study, we constructed a recombinant plasmid consisting of genes encoding the truncated influenza A virus antigenic protein, hemagglutinin (HA1), and the cell wall binding domain protein, N–acetylmuraminidase (AcmA), which are linked together by a single-chain variable fragment (scFv) linker. The recombinant plasmid was transformed into *Escherichia coli* and the expression of the HA1 fusion protein was induced using isopropyl β-D thiogalactosidase (IPTG). The inclusion bodies formed were purified under denaturing condition by affinity chromatography and refolded by dialysis. The resulting functionally active fusion protein was surface displayed on the *L. lactis*. Optimizations were performed to improve the binding capacity of the HA1 fusion protein onto the surface of the *L. lactis*. This construct, the *L. lactis* surface displaying HA1 fusion protein, was then administered into