KEMRI | Wellcome Trust

# RESEARCH BRIEF

April 2019

# Substantial population protection from Invasive Pneumococcal Disease associated with PCV10 vaccine program in Kilifi, Kenya


## Summary

The Pneumococcal Conjugate Vaccine Impact Study (PCVIS) has demonstrated the population effects of 10-valent Pneumococcal Conjugate Vaccine (PCV10) in Kenya. This brief focuses on the substantial impact of PCV10 on invasive pneumococcal disease (IPD) and pneumococcal carriage and highlights areas for further research


## Results and further research

**PCV10 immunization program coverage**

- Eighty-four percent of 2-11 month old infants had received ≥2 PCV10 doses in 2016

**PCV10 effectiveness**

- PCV10 reduced vaccine-type IPD by 92 percent in children under five, showing that the vaccine is highly effective in protecting children against the 10 strains of pneumococcal bacteria that it targets
- PCV10 reduced all IPD in children by 68 percent, showing that the 10 strains of pneumococcal bacteria targeted comprise a large proportion of all IPD

**Population protection**

- PCV10 reduced vaccine-type IPD in unvaccinated populations, showing that PCV10 provided substantial population protection (herd immunity)
- PCV10 reduced the carriage of vaccine type bacteria in Kenya, but not to the very low levels seen in middle- and high-income countries

**Serotype replacement disease**

- Evidence of serotype replacement disease was not found up to six years after the introduction of PCV10

**Further research is needed to:**

- Find ways of reducing the per-child cost of PCV10 to make the vaccine program sustainable once Kenya transitions from Gavi-support
- Continue to monitor for incidence of serotype replacement disease
- Understand the persistent prevalence of vaccine type pneumococcal carriage

PCVIS Pneumococcal Conjugate Vaccine Impact Study

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Gavi The Vaccine Alliance

REPUBLIC OF KENYA MINISTRY OF HEALTH

## About Kenya's PCVI0 vaccine program

In 2011 Kenya was the first African country to include PCVI0 in its childhood immunization schedule, with support from Gavi, The Vaccine Alliance. Children under 12 months of age were given three doses of the vaccine, and, in Kilifi County, children under five were given two doses through a catch-up campaign. The catch-up campaign aimed to give children under five the same protection as if they had received the vaccination in infancy. In the first year of vaccine introduction, coverage for infants aged 2-11 months reached 80 percent and remained high thereafter.

## About the Pneumococcal Conjugate Vaccine Impact Study

The Pneumococcal Conjugate Vaccine Impact Study (PCVIS) is one of the first field studies to provide population-level evidence of the impact of PCVI0 on IPD and carriage in a lower-middle income country. PCVIS is the largest and longest before-after study of PCV impact in tropical Africa.

PCVIS has collected data in Kenya since 2008 through an integrated system that connects census data from the Kilifi Health and Demographic Surveillance System - the largest demographic surveillance system in Africa - with clinical data from Kilifi County Hospital, laboratory analyses and vaccination coverage data from health facilities throughout Kilifi County.

## Results in context

In 2017 the Pneumococcal Conjugate Vaccine Review of Evidence (PRIME) identified 39 studies evaluating the impact of PCVI0 or PCVI3 on IPD caused by vaccine serotypes using three-dose schedules (2+1 or 3+0). The majority of the studies were from Europe (n=20), with 7 from Africa, 4 from Latin America, 3 from Australia/Oceania, 3 from North America, and 2 from Asia. The results from PCVIS therefore make a substantial contribution to the evidence of PCVI0 impact on IPD in Africa.

**Photo:** census data from the Kilifi Health and Demographic Surveillance System, Kenya

## PCVIS results

### Ninety-two percent reduction in vaccine type IPD

PCVI0 reduced vaccine type IPD by 92 percent among children aged under five years. Before vaccine introduction the disease incidence rate was 60.8 per 100,000 person years (1999-2010) compared to 3.2 per 100,000 person years after PCVI0 was introduced (2012-2016).

### Seventy-four percent reduction in all IPD

PCVI0 reduced all IPD among children aged under five years by 68 percent, showing that the 10 strains of pneumococcal bacteria targeted by PCVI0 comprise a large proportion of all IPD. Before vaccine introduction the disease incidence rate was 81.6 per 100,000 person years (1999-2010) compared to 15.3 after PCVI0 was introduced PCVI0 (2012-2016). Almost all disease seen after vaccine introduction was caused by strains not targeted by the vaccine.

### Population protection: significant reduction in vaccine type IPD in unvaccinated populations

Vaccine type IPD declined significantly in unvaccinated age groups (less than two months, five-14 years, and 50+ years) with estimated vaccine effectiveness of 100%, 74 percent and 81 percent respectively. This is because of the high vaccination coverage of PCVI0 among children who are then much less likely to pass pneumococcal bacteria to unvaccinated people.

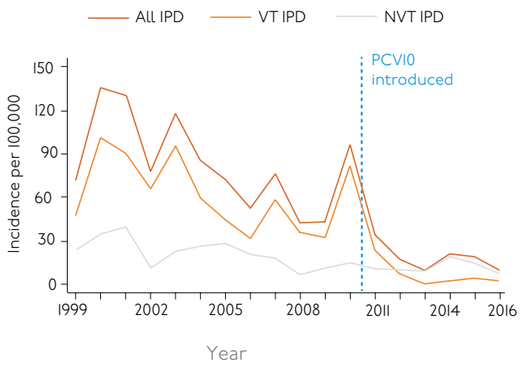
### Carriage of vaccine type bacteria reduced, but not to levels seen in middle- and high-income countries

Vaccine type pneumococcal bacteria continue to be found in six percent of children under five years and six percent of infants in Kilifi, compared to less than two percent in other countries that use PCVs. This could be due to a higher force of infection and therefore unvaccinated or under-vaccinated children and adults could be at continued risk of contracting vaccine type IPD. Or, it could be because there is no booster dose in the second year of life and immunity wanes. This could lead to a persistent group of people who can pass on the vaccine type bacteria leading to vaccination failure or rebound disease incidence.

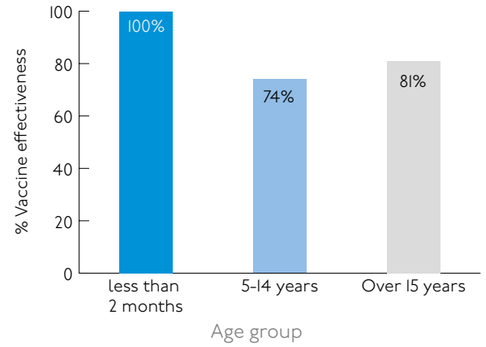
### Serotype replacement disease: Carriage of non-vaccine type bacteria increased but no increase in disease was observed

When a vaccine starts to eliminate certain strains of bacteria from a population, other strains can take their place. This is known as serotype replacement disease. Six years after the introduction of PCVI0 in Kilifi, there was an increase in carriage of non-vaccine type pneumococcal bacteria, particularly serotype 19A, across all age groups. Non-vaccine type pneumococci contributed only 25 percent of cases of IPD before PCVI0 was introduced, and while there was a small increase in non-vaccine type disease after PCVI0 was introduced, the change was not significant.

Reduction in incidence of all IPD and vaccine type IPD following PCVI0 introduction in children aged under five years




Substantial protection from vaccine type IPD in unvaccinated populations after PCVI0 introduction



## Further research is needed

The population-level protection provided against vaccine type pneumococcal bacteria justifies continued inclusion of PCV10 in national childhood immunization schedules.

However, further research is needed to:

### Find ways to reduce the per-child cost to make the vaccine program sustainable once Kenya graduates from Gavi-support

Currently, PCV10 is the most expensive vaccine in Kenya's immunization program. Options include:

- Developing a cheaper vaccine
- Reducing the dose quantity
- Reducing the number of doses a child receives.

### Monitor serotype replacement disease

It will be important to monitor non-vaccine type IPD in children and adults for several more years, since serotype replacement disease has become a problem in some high-income countries where PCVs have been in use for longer.

### Understand persistent prevalence of vaccine type pneumococcal bacteria

We need to find out why a relatively high percentage of children still carry vaccine type bacteria.

A booster dose in the second year of life, as is done in most middle- and high-income countries, could reduce vaccine type pneumococcal carriage in under-fives. This is being tested in studies in South Africa and Vietnam. Alternatively, it may be necessary to give an additional dose to older cohorts of children who received a vaccine series in infancy. Only if near-elimination of vaccine type carriage can be achieved (complete herd immunity), does it become safe to test reducing the number of doses.

**KEMRI Wellcome Trust Research Programme is currently engaged in research in all these areas.**

## References


- This research brief is based on the following paper: Hammitt LL, Scott AG et al. Effect of ten-valent pneumococcal conjugate vaccine on invasive pneumococcal disease and nasopharyngeal carriage in Kenya: a longitudinal surveillance study. **The Lancet.** Published online 15 April 2019. http://dx.doi.org/10.1016/S0140-6736(18)33005-8
- PCV Evidence Base, January 2017 www.jhsph.edu/research/centers-and-institutes/ivac/resources/PCVEvidenceBase-Jan2017.pdf (last accessed March 2019)
- Pneumococcal Conjugate Vaccine Review of Impact Evidence (PRIME) systematic review summary findings www.who.int/immunization/sage/meetings/2017/october/3_FULL_PRIME_REPORT_2017Sep26.pdf (last accessed March 2019)
- For information about PCV impact studies, see: International Vaccine Access Center (IVAC), Johns Hopkins Bloomberg School of Public Health. VIEW-hub. www.view-hub.org (Last accessed March 2019)