

# Modeling Various Vaccination Strategies Against Streptococcus Pneumoniae

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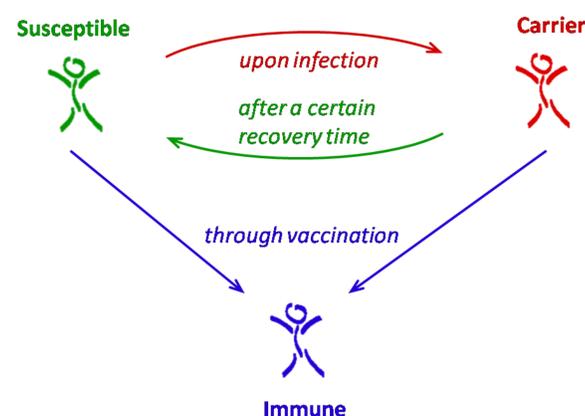
## INTRODUCTION

### Streptococcus Pneumoniae:

- Bacteria that causes diseases like pneumonia, otitis media, meningitis and sepsis.
- Many carriers while only a few people fall sick with it.
- Mostly small children and old people are affected because of their weak immune system.
- New vaccine PCV7:
  - Protection against 7 common serotypes.
  - Applicable also for infants.

### Model:

- Dynamic multi agent based model.
- Agents are single persons.
- Differentiate between serotypes that are covered by PCV7 and serotypes that are not covered.



### Presumptions based on medical data:

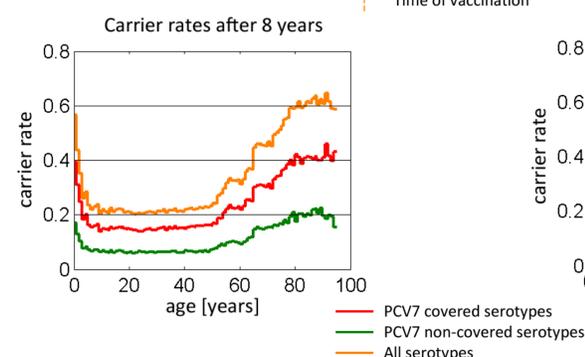
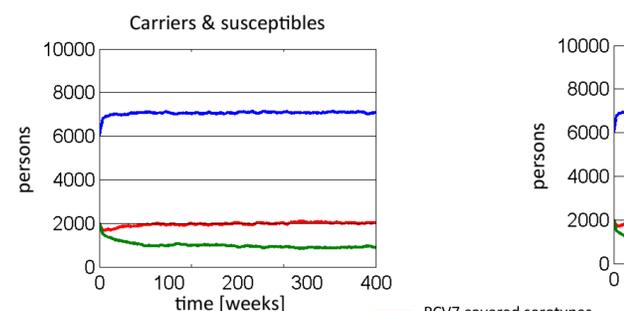
- A person can be carrier of one serotype only at one time.
- A person becomes a carrier if he/she gets infected and gets susceptible again when he/she recovers.
- Prevalence of serotypes covered in PCV7 is 70% in Central Europe.

### GOAL

Test the impact of different vaccination strategies on carrier rates.

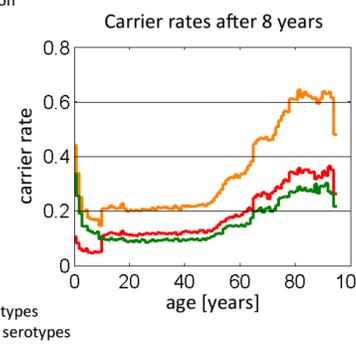
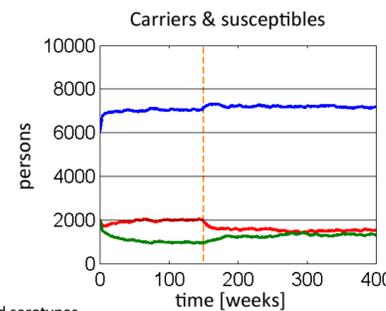
### Base Run

There is no vaccination simulated in the base run.



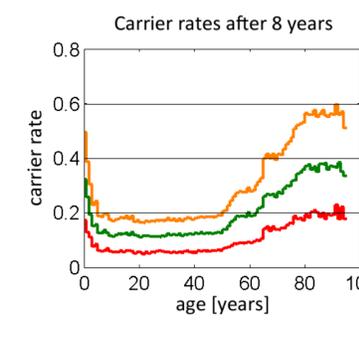
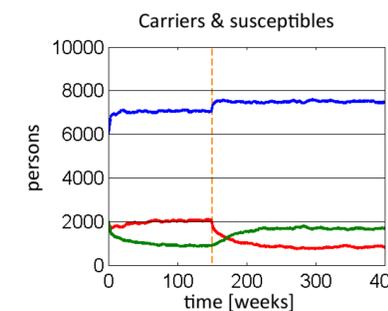
### Scenario 1

Vaccinate 50% of all children of age 0-9 at time 150 weeks.



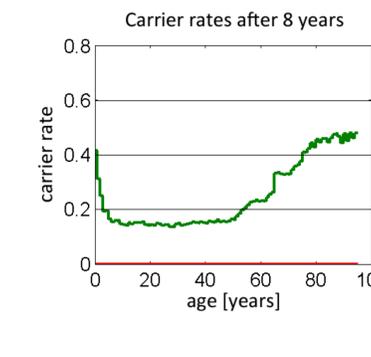
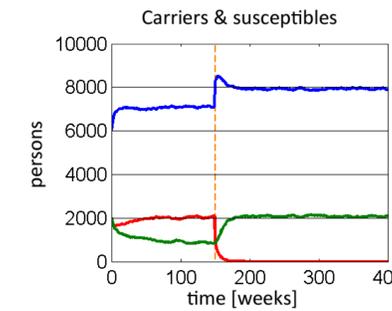
### Scenario 2

Vaccinate 10% of all persons at time 150 weeks.



### Scenario 3

Vaccinate 50% of all persons at time 150 weeks.



**Results:** After a short adaption from the start values in the first few timesteps results show stable carrier rates for the whole simulation time. The detailed diagram shows the prevalence of both considered groups of serotypes and higher carrier rates for children and old people.

**Results:** For the age group up to 9 years the cumulative carrier rate is reduced by about 20% while non covered strains take up to 70% of all carriers. For people of age 10 years and above the cumulative carrier rate does not change while a strong serotype replacement causes a significant strengthening of non covered serotypes.

**Results:** Vaccination of 10% of the population results in a reduction of almost 15% of the cumulative carrier rate due to an effect of herd immunity. Coincidentally the ratio of prevalent serotypes changes rapidly so that non covered serotypes reach a prevalence of about 60% after the vaccination.

**Results:** This scenario shows the limits of this model where vaccination results in an extinction of the covered serotypes. Due to a strong serotype replacement, caused by a rise of non covered serotypes, a reduction of about 29% of all carriers can be reached. However in reality there might be a behavior that prevents a pathogen from being extinct which is not considered in the model.

## CONCLUSION

Serotype replacement occurs for every vaccination strategy and it gets stronger as more people are vaccinated. Scenario 3 shows the limits of the vaccine with extinction of the covered serotypes. Generally the impact of vaccinations on the cumulative carrier rate is significant but especially for higher vaccination coverage rates it is not as strong as it might be expected.