Full versus Partial Vaccination for Meningococcal Meningitis: A Mathematical Model

Schembri, Jemmima (School: Inaburra School)

This project aimed to determine the most effective and economically sustainable method of reducing the burden of meningococcal meningitis within the Meningitis Belt of Sub-Saharan Africa. The project investigated whether providing a partial vaccine to a greater percentage of the population has a greater effect than giving a full vaccine to a lesser percentage of the population. A Susceptible, Eclipsed (carrier), Infected, Recovered (SEIR) model was used to determine the effectiveness of six vaccine scenarios in reducing the total number of infected individuals. The model parameters were taken from Asamoah et al., 2018 and adapted to include vaccination (V(t)) and fatality (D(t)) compartments. The ‘inefficacy of vaccine (?e)’ was determined by subtracting the effectiveness from one. To determine the ?e for the partial vaccination scenarios the full vaccination ?e was multiplied by two. The effectiveness of full vaccination scenarios (receiving all four recommended doses for meningococcal meningitis) was investigated with 12.5%, 25%, and 37.5% of the population vaccinated, under an ‘inefficacy of vaccine’ (?e) parameter of 0.05. Partial vaccination scenarios (receiving half of the recommended vaccines) were investigated with 25%, 50%, and 75% of the population vaccinated, under a ?e of 0.1. The model was completed with a hypothetical population of 1 000 000. Data analysis of each scenario demonstrates a reduced magnitude of epidemic peaks with increased vaccination rates. The results demonstrate a greater percentage of the population receiving partial vaccination is more effective than fewer receiving full vaccination, suggesting herd immunity is more effective for partial vaccination scenarios.

Awards Won: