**SUPPLEMENTARY ONLINE MATERIAL**

**Meningococcal transmission model with differential equations**

MR = infected – seroprotected (vaccine-preventable); M = infected (vaccine-preventable); MD = meningococcal disease (vaccine-preventable strains); SR = susceptible – seroprotected; S = susceptible; MDeath = death due to Invasive Meningococcal Disease (IMD); OR = infected – seroprotected (non-vaccine-preventable); O = infected (non-vaccine-preventable); OD = meningococcal disease (vaccine-preventable strains);

λ = force of infection; γ= vaccine efficacy against carriage acquisition (subject level); Ψ = effective coverage proportion; r = recovery rate from carriage; W = waning; case fatality rate; φ = rate surviving meningococcal disease; invasive disease rate;m = proportion of carriers of vaccine-preventable strains who recover immediately after successful vaccination; ζ = factor indicating higher waning under carriage; factor indicating different case fatality rate from other strains, τ = factor indicating different invasive disease rate for other strains; i = age stratum

Note: all-cause mortality is not covered in the figure above

The following equations describe the flow through the transmission model:

**Vaccine-preventable strain carriers vaccinated with resulting sero-protection**

 (1 - m) \* ΨRi(t)\* Mi(t) + (1 - γ) \* λMi(t) \* SRi(t) - (1 + ζ)\*WRi \* MRi(t) - rMi MRi(t)

**Susceptibles vaccinated with resulting seroprotection**

 rMi\*MRi(t) + rOi\*ORi(t) \* + ΨRi(t)\*Si(t) + m\*ΨRi(t)\*Mi(t) - λOi\*SRi(t)
 - (1 - γ)\*λMi(t)\*SRi(t) - WRi\*SRi(t)

**Other strain carriers vaccinated with resulting seroprotection**

 ΨRi(t)\*Oi(t) + λOi(t)\*SRi(t) - (1 + ζ)\*WRi\*ORi(t) - rOi\*ORi(t) - τ\*Mi(t)\*ORi(t)

**Vaccine preventable carriers non-vaccinated or vaccinated without seroprotection**

 λMi(t)\*Si(t) + (1 + ζ)\*WRi\*MRi(t) - (1 - m) \* ΨRi(t)\* Mi(t) - m\*ΨRi(t)\*Mi(t) – rMi\* Mi(t)
 - Mi(t)\*Mi(t)

**Susceptibles non-vaccinated or vaccinated without seroprotection**

 rMi\* Mi(t) + rOi\*Oi(t) + WRi\*SRi(t) + φMDi(t)\*MDi(t) + ς\*φMDi(t)\*ODi(t) - λMi(t)\*Si(t)
 - λOi(t)\*Si(t) - ΨRi(t)\*Si(t)

**Other strain carriers non-vaccinated or vaccinated without seroprotection**

 λOi(t)\*Si(t) + (1 + ζ)\*WRi\*ORi(t) - rOi\*Oi(t) - ΨRi(t)\*Oi(t) – τ\*Mi(t)\*Oi(t)

**Invasive Meningococcal Disease cases due to vaccine preventable strains**

 Mi(t)\*Mi(t) - φMDi(t)\*MDi(t) – i\*MDi(t)

**Invasive Meningococcal Disease cases due to other strains**

 τ\*Mi(t)\*Oi(t) + τ\*Mi(t)\*ORi(t) - ς\*φMDi(t)\*ODi(t) – \*i\*ODi(t)

**Number of meningococcal deaths**

 i\*MDi(t) + \*i\*ODi(t)

