Waning Modeling MEthods and Results

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Model and parameters

We used a simple, unstructured, susceptible-infectious-removed (=SIR) model to simulate the influenza transmission in a large population. The following parameters were chosen:

Parameter	Symbol	Value
Total Pop.	N	$2.0e+06$
Beginning vaccination uptake	p_v	0.47
vaccination uptake rate	ν	0
Removal rate	γ	0.25
Basic reprod. No.	R_0	1.4
Transmission coeff., unvacc.	$\beta = \frac{R_0\ \gamma}{N}$	1.4
Transmission coeff., vacc.	$\beta = \frac{R_0\ \gamma\ (1-\phi)}{N}$	1.4
VE	ϕ	$0.2, 0.3, 0.4, 0.5$
Pre-esisting immunity	ϵ	0

The following initial values were used:

Parameter	Symbol	Value
No. susceptible, vacc.	x_v	$9.4e+05$
No. susceptible, unvacc.	x_{nv}	$1.1e+06$
No. infectious, vacc.	$y_v = \frac{p_v\ \phi}{p_v\ \phi + 1 - \phi}$	$0.15, 0.21, 0.26, 0.31$
No. infectious, unvacc.	y_{nv}	0.69
No. removed, vacc.	z_v	0
No. removed, unvacc.	z_{nv}	0

The model used is given by the following system or differential equations:

$$\begin{aligned}
\frac{x_v}{dt} &= -\beta\ (1-\phi)\ x_v\ (y_v + y_{nv}) + \nu\ x_{nv} \\
\frac{x_{nv}}{dt} &= -\beta\ x_{nv}\ (y_v + y_{nv}) - \nu\ x_{nv} \\
\frac{y_v}{dt} &= \beta\ (1-\phi)\ x_v\ (y_v + y_{nv}) - y_v\ \gamma \\
\frac{y_{nv}}{dt} &= \beta\ x_{nv}\ (y_v + y_{nv}) - y_{nv}\ \gamma \\
\frac{z_v}{dt} &= y_v\ \gamma \\
\frac{z_{nv}}{dt} &= y_{nv}\ \gamma
\end{aligned}$$

The system is numerical solved using the ode function from the deSolve package.

Results

The trajectories are only shown for the periods of time when there was substantial transmission (more than 10 infectious) and aligned at their “start times”.

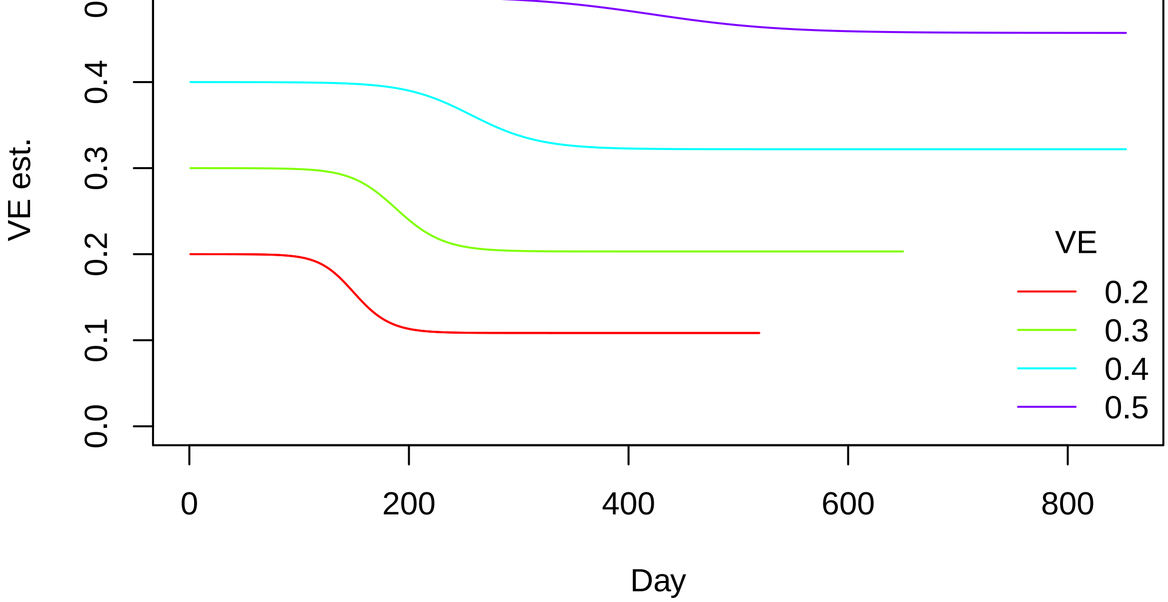

Figure 1: Expected VE estimates over time, by VE

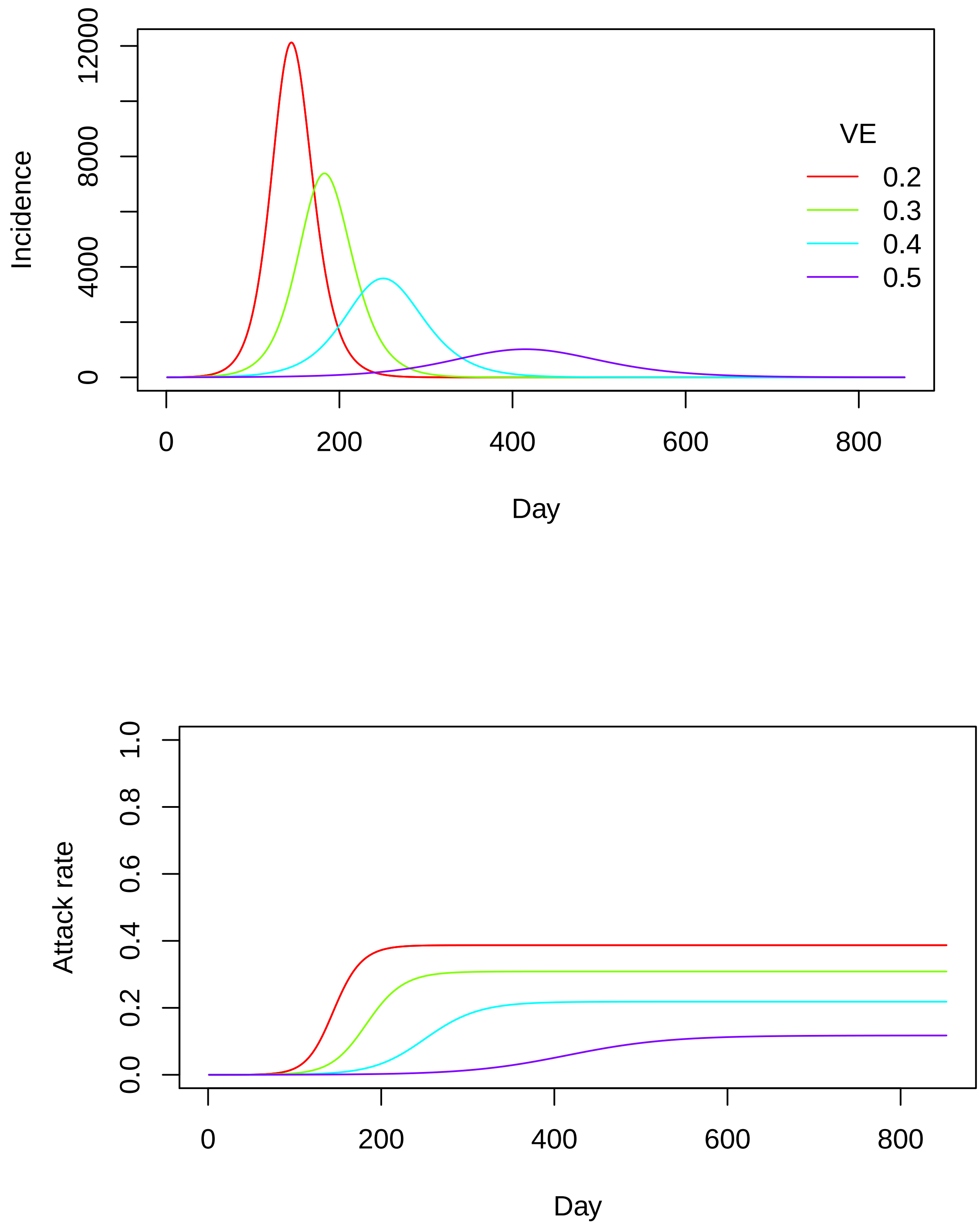

Figure 2: Epi curve (top) and cummulative attack rates (bottom) over time, by VE