The efficacy of vaccination for the eradication of rage-virus mediated zombieism.

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The movies *28 Days Later* and its recent sequel *28 Weeks Later* tell the story of a lab secretly engineering a virus (the rage virus) that will control the violent impulses of those that it infects. Naturally, the virus mutates into a dangerous form that does just the opposite. Those infected display zombie-like symptoms, and transmit the virus to others through excessively violent biting (Figure 1). Unfortunately, this virus was accidentally released into the population of Great Britain, with devastating effects. The recent recognition that some individuals are immune to the rage virus (see the movie *28 Weeks Later*) has raised hopes for a vaccine, but here I use standard techniques from mathematical epidemiology to show that such vaccines are unlikely to provide a satisfactory means of eradicating this form of zombieism.

Figure 1: Young man shortly after infection with rage virus. *Photo credit: Mike Delorme*

To begin, we must estimate a quantity referred to as the basic reproduction number, R_0. This number represents the average number of new zombies created (through transmission of the rage virus) by a single zombie, when introduced into a wholly susceptible population. Standard results show that the basic reproduction number is given

by $R_0 = S_0(\ln S_0 - \ln S_\infty)/(S_0 - S_\infty)$, where S_0 is the initial size of the population, and S_∞ is the number of individuals that manage to avoid infection. There are ~ 60 million people in Great Britain and roughly 1000 avoided infection, giving a basic reproduction number of $R_0 \approx 11$. This can then be used to calculate the fraction of the population that must be vaccinated to eradicate this disease as $(R_0 - 1)/(1 - \phi)R_0$. Here, ϕ is a measure of vaccine effectiveness, with $\phi = 0$ meaning the vaccine is perfect (vaccinated individuals display no transmission) and $\phi = 1$ meaning the vaccine is useless (vaccinated individuals display the same level of transmission as unvaccinated individuals).

Figure 2 depicts the combinations of vaccine effectiveness and vaccination coverage that are required to eradicate zombieism. Notice that a vaccine can never eradicate the disease if its effectiveness is less than approximately 0.09 (i.e., the vaccine must reduce transmission by at least 91%). Furthermore, even for highly effective vaccines, Figure 2 demonstrates that the vaccination coverage required for eradication is unrealistically high. Consequently, other control measures, such as the slaughter/incineration of infected individuals that has been so successful for past disease outbreaks in Great Britain, are likely to provide a better approach.

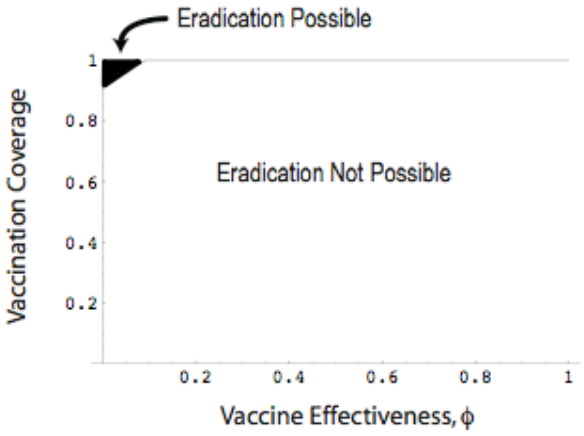

Figure 2: Shaded region indicates the combination of vaccine effectiveness and vaccination coverage required to eradicate rage-virus mediated zombieism.