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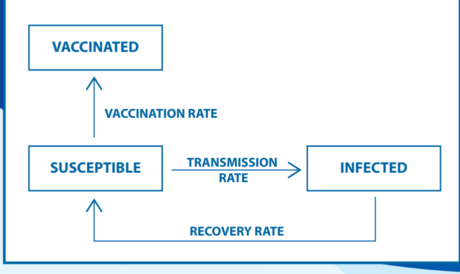

MALARIA VACCINES

Saving lives with the help of mathematics

Malaria is one of the deadliest diseases on the planet, killing a child in Africa every few minutes, and infecting over 200 million people annually. Despite being one of the world's best known and most prolific diseases, there is no highly effective vaccine.

Malaria is caused by a parasite which is transmitted by infected mosquitoes. One of the reasons it has been so difficult to develop a vaccine is that the parasite has a vast array of surface coats, making it hard to develop a vaccine which will protect against the different strains of malaria, each of which has its own collection of these surface molecules.

Even though the malaria parasite is constantly changing its disguise, researchers at the University of Oxford have recently discovered one molecule called RH5 which is common to all strains of the most deadly malaria parasite. This exciting new discovery offers hope that a vaccine containing RH5 will prevent many deaths due to malaria.

Once the researchers have identified a potential vaccine they use mathematical equations to model the possible impact their new treatment might have. This is done by first dividing the population into different categories. People are either in the Susceptible (S) category, the Infected (I) category or the Vaccinated (V) category. People move between categories like in the diagram above.

The transmission rate will depend on preventative measures such as the use of bed nets, and the recovery rate will depend on the use of drugs to aid recovery. People can be repeatedly infected with malaria so, once they recover from one episode, they return to the susceptible category.

The two mathematical equations which govern how people move between the categories are as follows:

$$\frac{dS}{dt} = -(\lambda + \nu)S + \sigma I \qquad \frac{dI}{dt} = \lambda S - \sigma I$$

This is where λ is the rate of transmission, ν is the vaccination rate, and σ is the rate of recovery from infection.

These mathematical equations allow the researchers to model what will happen when a population starts to be immunised against malaria. It is likely that only a proportion of a population will be vaccinated, meaning that these models allow researchers to assess what levels of vaccination will be needed to make a significant impact on the disease. It is also likely that the vaccine may not offer full protection, and this can be incorporated into the model by modifying the parameter ν.

Researchers are also now looking at how the pathogens that cause malaria evolve into different strains. The model is adapted so that it categorises people according to which particular strain of malaria they have experienced, in turn allowing the researchers to model how molecules shared between all strains, such as RH5, can be exploited to make smarter vaccines against this deadly disease.

www.medsci.ox.ac.uk/designer-malaria-vaccines
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