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The impact of vaccinating behaviour on the natural history of immunization programmes.

Recent theoretical studies have provided increasing evidence that human behaviour can play a critical role in the achievement of public health targets, such as the mitigation of a pandemic influenza outbreak or the success of a vaccination programme for a childhood infection. As for the area of vaccine preventable infections, much of the recent research has focused on the impact of immunization choices - modelled as an evolutionary game with imitation dynamics - on voluntary vaccination regimes, particularly the issue of vaccination free-riding. In this paper we first use a simple transmission model with vaccination payoff modelled as an increasing function of the incidence of vaccine side effects, to interpret historical trends in serious morbidity and mortality from various childhood infections. This allows us to clearly show which are the major killers of vaccination programmes in industrialised countries. These seem mainly to be the technological progress and the ensuing epidemiological transition, which during the last century have brought down to negligible levels the perceived risks of serious disease given infection, and the sustained vaccination programmes conducted in the past, which have brought down to negligible levels the perceived risks of infection. This yields rather pessimistic predictions about the future lifetime of vaccination programmes. Subsequently, motivated by the fact no current vaccination regimes are fully voluntary, we propose a new framework aimed to predict the dynamic effects of the interplay between inter-human and public information on vaccine uptake, based on a modified evolutionary game equation for the vaccinated proportion, including the effort of the public health system as well. The underlying idea is that the hazard of becoming a vaccinator is the sum of two components, one due to information spread through inter-human contacts (e.g. imitation), and one due to information spread by the public health system. Unlike the former, the latter aims to suggest a very small, possibly zero, perceived risk of vaccine side effects, and a larger, possibly prevalence independent, risk of disease. Our main results show that public intervention can play a stabilising role capable to reduce the violence of 'imitation' induced oscillations, to allow for disease elimination, and to even make the so called Disease Free Pure Vaccinators Equilibrium Globally attractive. This suggests that keeping a degree of public intervention in otherwise voluntary vaccination regimes might be the only way to mitigate the pessimistic conclusions reported above.